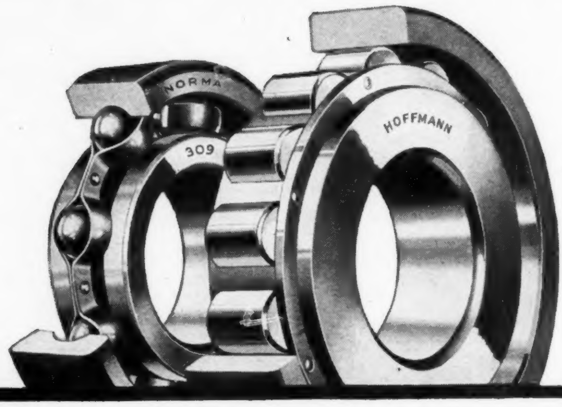
OCTOBER
1929

MACHINE DESIGN

as it affects

ENGINEERING–PRODUCTION–SALES

Methods–Materials–Parts



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NORMA-HOFFMANN BEARINGS CORPN.—STAMFORD CONN. U.S.A.

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ENGINEERING-PRODUCTION-SALES

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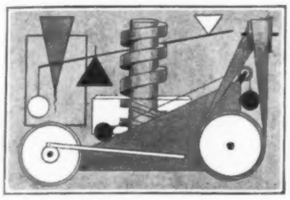

Next
MONTH

WHILE the responsibility for the design of a machine rests largely upon the designer, the thoughts or ideas on which the design is based may arise from many and varied sources. For this reason Machine Design will include from time to time articles showing how the engineering department may profit from coordination with others.

In the present issue cooperation with the sales department is dealt with. Supplementing this, another phase of customer contact—and its relation to design—will be taken up in the November number. This article, prepared by a writer well qualified to handle the subject, treats the matter from the service end.

L. E. Jermy.
Managing Editor

CONTENTS

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MACHINE DESIGN

October *1929*

Overcoming Design Problems in Front-Wheel Drives

By Austin M. Wolf

Automotive Consulting Engineer, Newark, N. J.

TWO American and several European front-wheel drive cars are now on the market. While others are being experimented with, the basic idea of this form of propulsion is by no means new, having been incorporated in some of the earliest vehicles built. In many designs it was combined with provision for steering the vehicle. Rear-wheel steering, which was used in an early electric cab and also a four-wheel drive truck of the war period which had front steering besides, is impractical due to the inability of the rear wheel to clear a curb if standing beside it, without mounting it.

The chief problem therefore lies in the design of a front axle construction combining the functions of driving and steering. This has been accomplished in four-wheel drive trucks. The power is conveyed from the transmission to a transfer case located approximately amidship, from whence a propeller shaft with universal joints reaches fore and aft to each axle. The front axle incorporates a universal joint within the steering knuckle. Such a layout, as far as the front propeller shaft is concerned, is not adaptable to passenger car use due to the necessarily high location of the power plant for under clearance and the excessive overall length of the entire mechanism. The driving-steering problem is coupled with the necessity for compactness and the absence of mechanism behind the dash to

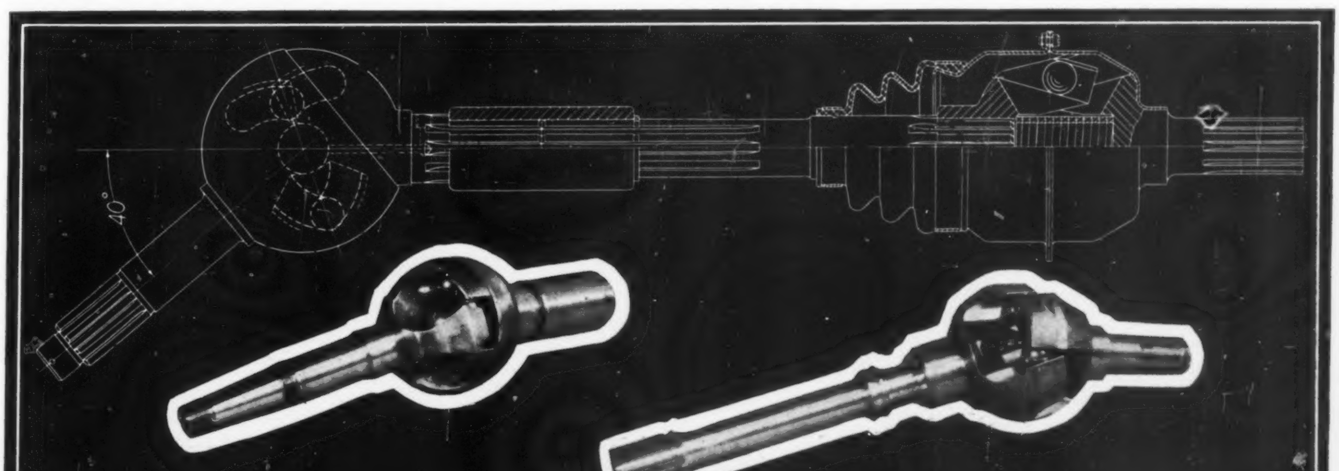


Fig. 1—Weiss universal joint with circular raceways, at left. Inboard joint provides for rolling end motion by movement of balls in straight raceways. Inserts assist in visualizing the joints

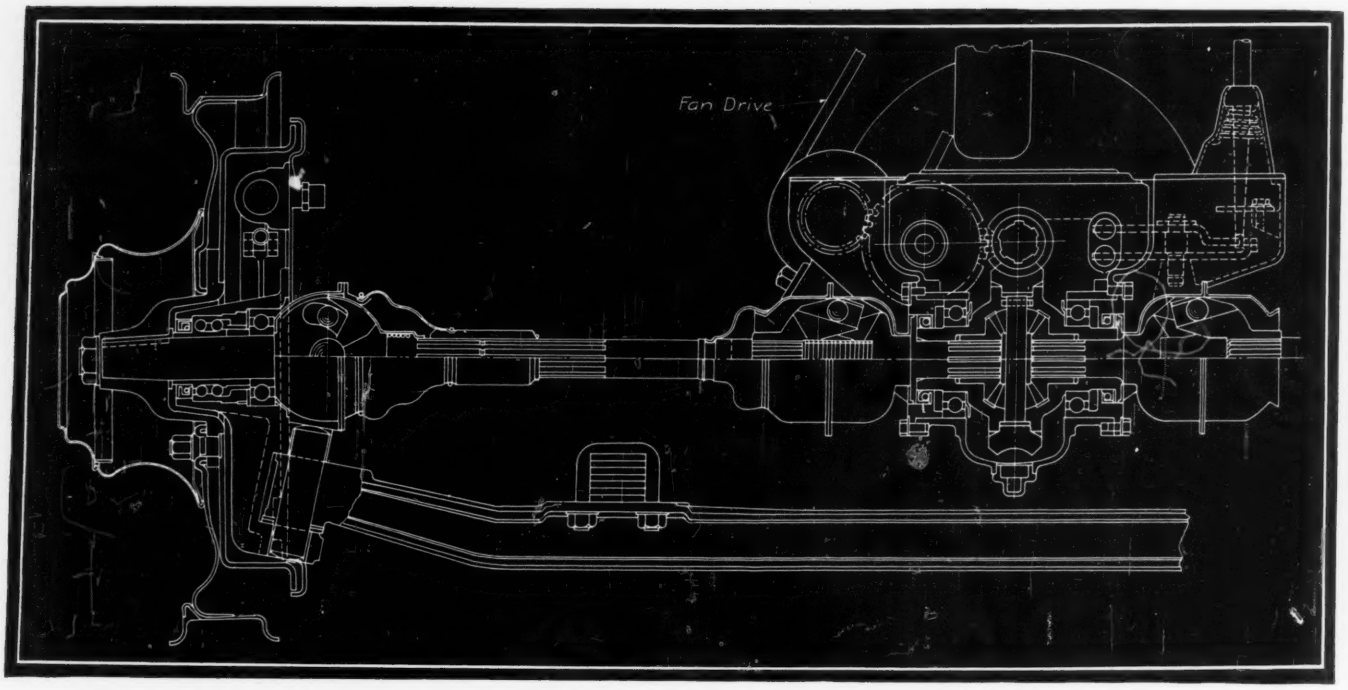


Fig. 2—Ruxton front axle and driving parts

place no restrictions on body height or dimensions. Therefore, it is compulsory to discard the longitudinal propeller shaft design.

Present designs incorporate a unit power plant with the engine and transmission in the reversed position to that of the ordinary rear drive car, with the final drive (bevel gear, hypoid or worm) combined with the transmission or immediately in front, as shown in Fig. 3. Since all these parts, up to and including the differential gear, are mounted on the frame, they constitute sprung weight and result in lessened unsprung axle weight.

Conveying Power Is Major Problem

A further problem lies in conveying the power from the differential to each front wheel. While two pairs of bevel gears have been used to drive the wheel and yet allow it to swing about the steering knuckle pin axis (which also is the pinion axis of one pair of gears), the majority of designs have incorporated a universal joint whose center is on this axis. A short shaft runs to another joint secured to the differential shaft. The latter joint is of the slip type which allows in and out movement of the shaft with rise and fall of the wheel during spring deflection, as shown in Figs. 2 and 8. The range of angularity of this joint is slight but the outer joint, which must also compensate for wheel movement when steering, is subjected to an angle of 40 degrees each side of normal in the case of Fig. 2 and 41½ degrees in Fig. 8. The single joint of the cross-pin type does not give uniform angular velocity but periodical speed fluctuations when one shaft is deflected. This calls for a special design. In the double joint construction shown in Fig. 4, the center ring always bisects the angle between the two shafts. This results in the second joint balancing out the nonuniform velocity of the first, with the result that the wheel is driven at constant speed. In the joint shown in Fig. 1, steel balls roll in raceways ground in the joint yokes. These balls always assume a position in a plane that bisects the joint angularity making uniform velocity. A series of these joints still retains the inherent virtue of uniform velocity throughout.

A departure from the two cross-shaft constructions mentioned, lies in the use of a unit power plant with a rigid axle directly bolted to the transmission, instead of merely a differential case. The axle ends are provided with swivel-mounted

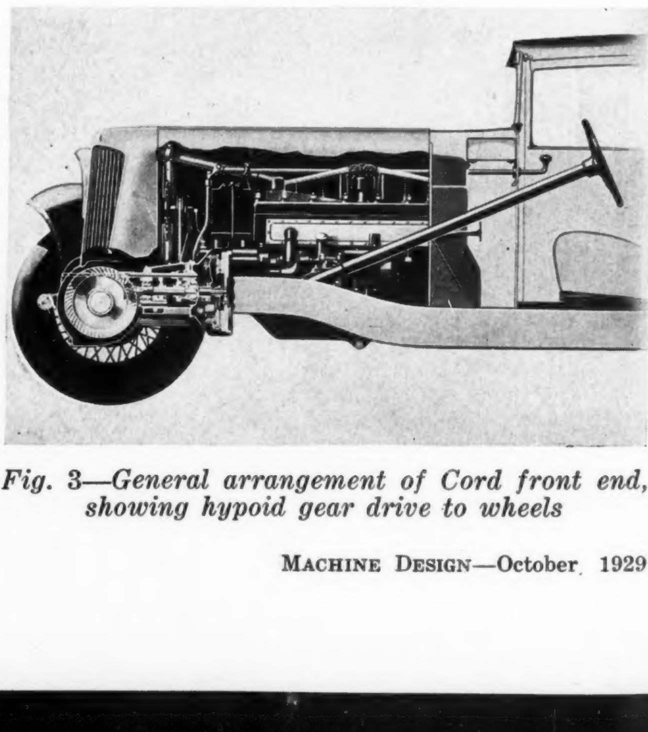


Fig. 3—General arrangement of Cord front end, showing hypoid gear drive to wheels

wheels, as shown in Fig. 9, with a universal joint of extreme yoke spread within the hub cap and at the end of the solid axle shaft. The power plant axle assembly is pivotally secured to the frame at the engine end. A suspension system interposed between the frame and axle completes the other connection. This construction has greater unsprung weight than the previously described types. It was incorporated in an experimental car which gave a very creditable performance in the last Pike's Peak hill climb.

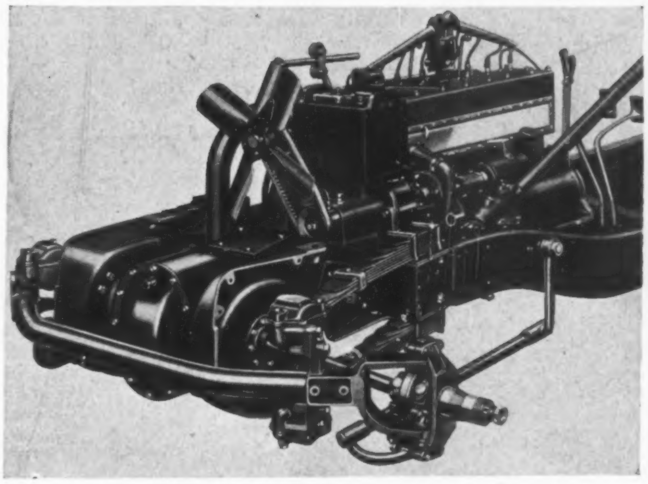


Fig. 6—Cord driving unit. Timing-chain case and battery are at front of engine. Gear shift rod is shown above battery

How Weight Is Transferred to Wheels

The next constructional feature to consider is the method of transferring the car weight to the wheels. European designers generally have utilized independent wheel suspension in the form of cross springs, divided axle halves swivelling about the differential center or the incorporation of coil springs in a steering knuckle integral with the frame, whereas a rigid load-carrying axle is used in the American designs now being marketed.

The construction shown in Fig. 6 was developed in racing. A tubular member is offset forward to clear the differential case and brake drums (the latter are mounted on the differential assembly and therefore brake through the joints) and is swedged into diagonally disposed, forged yoke ends whose king pin centers are in line with the drive shafts in plan view. Two quarter-elliptic springs at each side, reach forward from the frame in parallelogram fashion and are secured to the axle through the intermediary of rubber blocks under compression. In Figs. 2 and 5, the customary semi-elliptic spring suspension is used and the brake drums are attached to the wheels. The axle incorporates diagonal king pins for center-point steering and the wheel spindle forms a yoke about the pin and develops into a bearing supporting sleeve above. The bed is offset forward at its center to clear the worm housing.

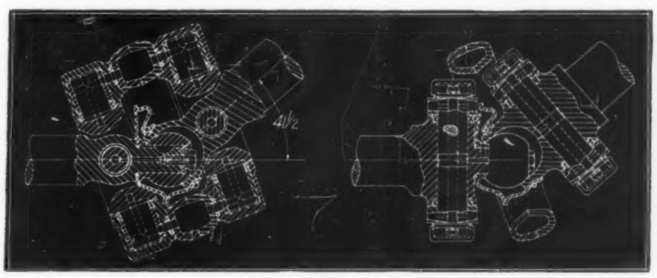


Fig. 4—Cord-mechanics universal joint. Ball centering member maintains constant intersection of shaft axes, allowing center ring to float midway

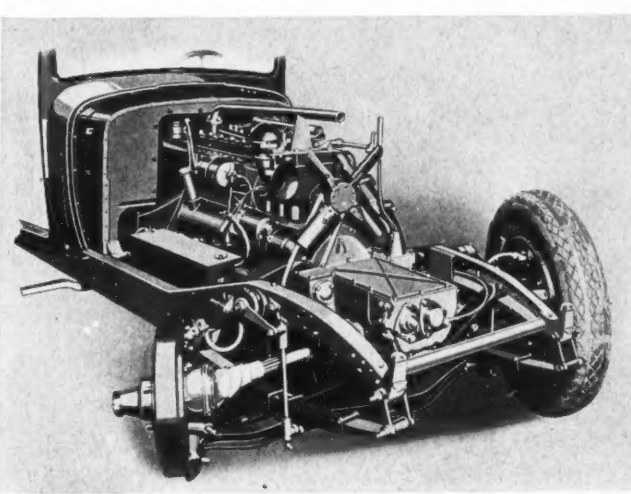


Fig. 5—Ruxton front end. Note axle bed speedometer drive, gear shift and battery location

The rear axle, being merely a weight sustaining member, becomes a simple unit. It carries brakes for the rear wheels; and the brake connections, other than the spring suspension, comprise the only mechanism between it and the frame. In the two American cars, hydraulic service-brake actuation is used and therefore a flexible hose forms the connection mentioned. Each also uses rear mechanical brakes operated by the emergency hand lever. The Cord car has a deeply dropped I-beam axle, while a tubular one with riveted-on cranked end spindles supports the Ruxton.

How Cord Drive Is Built

Details of the Cord drive are disclosed by the drawings in Fig. 7. These drawings have been included by the author by permission of *Automotive Industries,* and show horizontal and vertical sections of the transmission and driving units. The two separate units are bolted together to form one assembly. Main and countershafts lie in the same horizontal plane, as indicated at *A,* for the sake

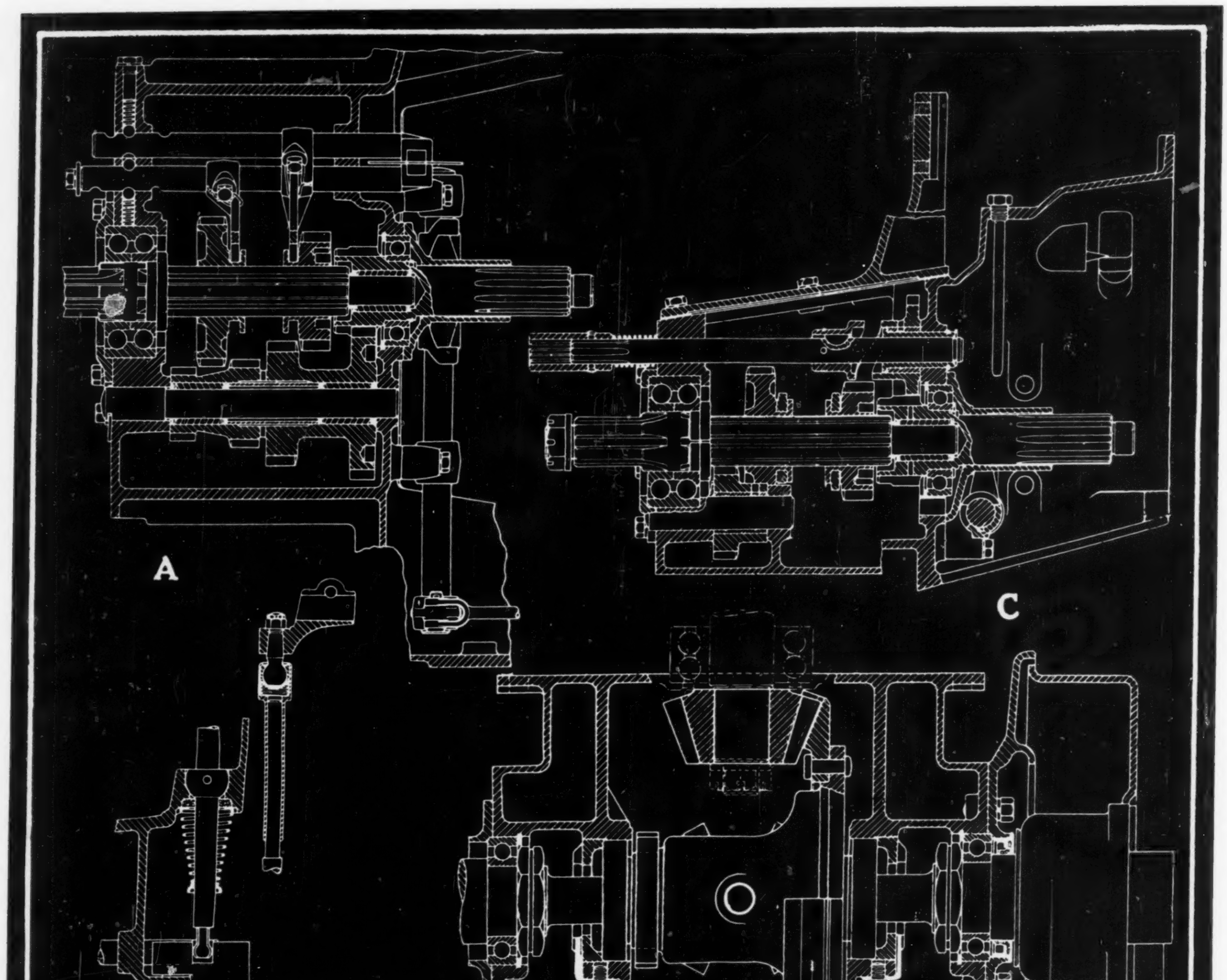


Fig. 7—Cord transmission details, showing: A, mainshaft and countershaft; B, ball mounted lever which engages front end of shift rod; C, cranking shaft above mainshaft; D, hypoid pinion on end of mainshaft; E, ball trunnion-slot type slip joints and differential

of ground clearance which does not apply to the conventional vertical arrangement and position. Gear shifting is accomplished by a rod extending back into the driving compartment and through a hole in the instrument board. An offset knob allows the operator to rock the shaft for selecting, and to push or pull to engage the desired gear. The front end of the rod engages the ball-mounted lever shown at *B*, which is otherwise like the customary hand operated one.

Facilities for Hand Starting

In the event of failure of the electric starter, cranking is made possible by inserting the hand crank in a supporting tube, after which it engages the shaft over the mainshaft as at *C*. It is provided with an engaging jaw, normally clear of the gear to the right which meshes with the clutchshaft gear. Right-hand cranking is possible due to counter-clockwise crankshaft rotation as a result of turning the engine around in the frame. Otherwise the transmission follows conventional design. The hypoid pinion of the driving unit shown at *D* is held on the end of the mainshaft instead of the customary universal joint flange. The slip-type joints adjacent to the differential are of the ball trunnion-slot type (see *E*). In the conventional car, rear end noises are minimized somewhat due to the isolation of the gearing from the chassis frame. With the unit construction of front drive cars, such noises would be transmitted directly to the frame, and resonate throughout the car. Hence we see the use of such quiet drives as hypoid and worm gearing.

The increased length between the dash and front axle over conventional designs is a vital consideration in the desire to prevent excessive overall car lengths. The body cannot be shortened for obvious comfort reasons. Saving of front-end length is accomplished in the Ruxton transmission-driving unit, shown at right in Fig. 2. Worm gear reduction is used in this case. Second speed and direct drive lie between the worm and the clutch, while reverse and first are on the other side or forward. A radiator apron neatly hides this forward extension. The horizontal levers located at the back of the gear shifting bars, reverse their motions and the vertical selecting lever therefore can pick up the gears according to the standard shift in spite of the turned-around position of the transmission. Copious lubrication is assured the worm gearing due to the walled-in construction used, which also adds rigidity to the case. The cooling fan belt is driven by a pulley mounted on a shaft having a Micarta gear in mesh with the countershaft constant mesh gear.

A radiator of high heat dissipating ability is necessary due to the limited space available. The driving mechanism prevents the depth usually used. Height cannot be excessive due to vision requirements and the blending of hood and body lines. Excessive width would also mar beauty. One helping factor is the greater distance between the fan and the cylinder block whereby

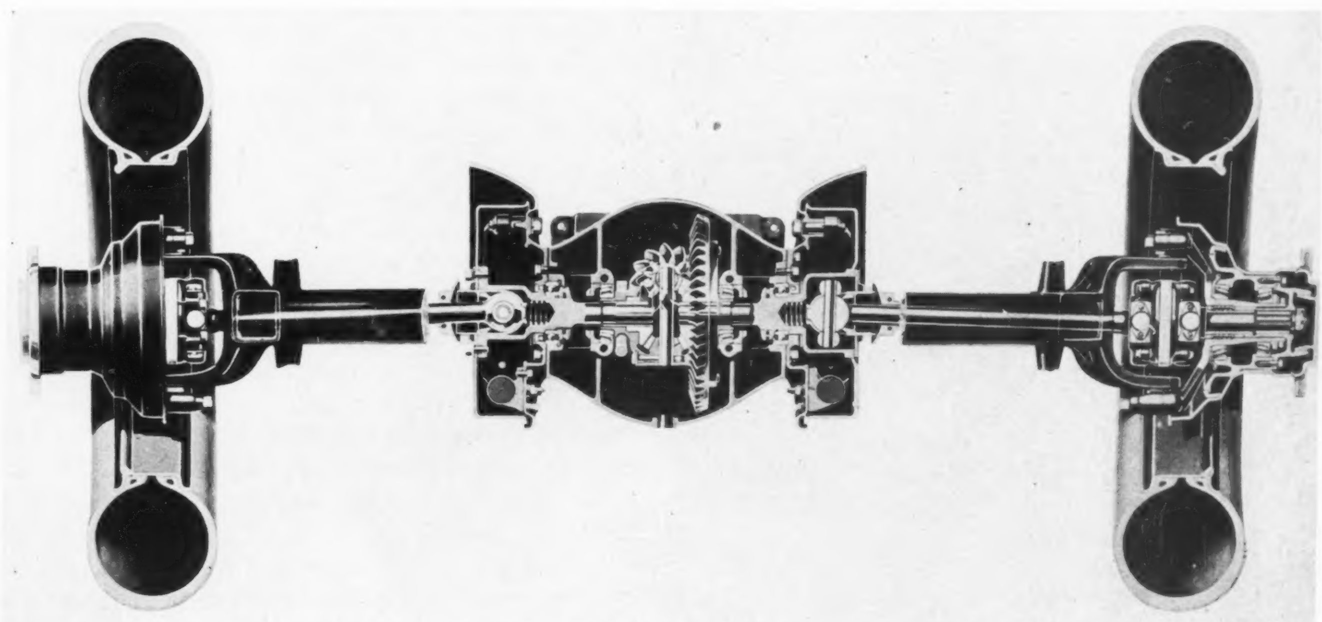


Fig. 8—Cord front axle, showing cross shafts and differential

the latter does not obstruct the air stream as it does in the customary layout.

Frame Design Is Changed

Frame design incorporates a kick-up at the front to hang the body in a low position, as in Fig. 3, and to give clearance for the drive shafts (see Fig. 5). The rear end of the Cord frame

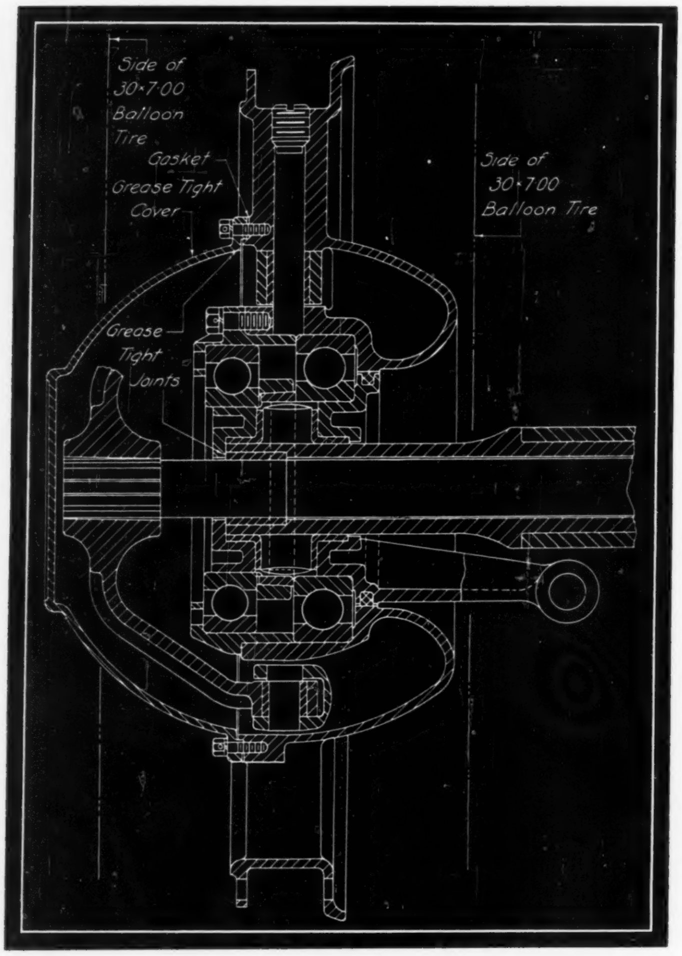


Fig. 9—Colman design. Pin at top shown 90 *degrees out of position to indicate its mounting*

has a raised lower flange, giving sufficient clearance over the deeply dropped axle. In the Ruxton frame the conventional rear kick-up is used because of the relatively smaller drop between the spindle and axle tube.

In view of the foregoing discussion, it will be realized that front-wheel drive gives a better riding car through the lowered center of gravity, lessened unsprung axle weight and better load distribution. Reduction of unsprung weight by means of two transverse shafts, originally introduced by De Dion of France as a rear drive, has never been accepted by American engineers until the present front-wheel drive situation forced them to it. It is reasonable to believe that certain advantages to be found in front drives would also be creditable to a rear driven car if such constructions were incorporated. The front drive may be a means to this end and an incentive for the more conservative engineer to adopt hitherto unconventional designs.

While the body space is unrestricted and the rear axle extremely simple, it must be admitted that the front end is highly complicated, with considerable mechanism crowded therein vulnerable to head-on collisions. A new vogue is introduced by the long hoods required, coupled with low hung bodies and body designers have a freedom never before experienced. The long hoods are doing missionary work for the makers of rear drive cars who are about to introduce V-16 and 12-in-line engined cars.

Increased safety is claimed because of lessened skidding tendency. This is assured while the wheels are driving and dragging the center of gravity behind the two points of power application. Some are of the opinion, however, that at high speed or with slippery roads, conditions are not so secure when the foot is taken off the accelerator pedal and two points of braking application (wheel resistance of engine which is being motored-over by the car momentum) exist in front of the center of gravity.

Front drive can accomplish what would be impossible with rear drive where the forward thrust of the rear wheels would in no way help the front end of the vehicle to "walk out" of a hole or mount an obstacle. A difficulty arises with front drive if the traction is decreased due to grade or when accelerating. This would hardly apply to passenger cars but would preclude its use on trucks with the continuance of present weight distribution.

Four-wheel drive overcomes the disadvantages of either front or rear drive. Its use in certain truck fields is absolutely established, and in fact expanding. However, its use in passenger cars seems a bit distant, unless exceptional road, grade or traction conditions are to be encountered. One designer considered these virtues sufficiently desirable to incorporate the system in a car that competed in the arduous Pike's Peak hill climb. With increasingly better roads, the demand for such a vehicle would be unnecessary from the present standpoint of traffic and traction requirements. To fit it into passenger cars would call for considerable design changes. However, there is a possibility that once the super-highways that are talked about today become a reality, the one hundred and more mile-an-hour speeds that will be necessary for the automobile to hold its place in the transportation field will call for a four-wheel drive passenger car.

Timely Re-statement of Fundamental Mechanical Principles

By Prof. John V. Martenis, M. E.
Chief, Machine Design Division,
University of Minnesota

MACHINE design has passed through many stages in its progress up to the present status of the art when it may properly be considered a science. There is room for improvement in methods and practices at present used in many industrial design departments where some of the men do not possess the training and background necessary to apply sound design principles or are not capable of making a thorough analysis of the forces entering into the operation of a machine. Empiricism and approximations or guesses have been too prevalent in design work. The use of diagrams and tabulated standards which were developed to meet certain conditions in design practice are commendable but the use of such labor saving devices necessarily must be restricted to the particular conditions for which they were produced. The chief of the test department of one of our large industries would not use a formula quoted in a standard handbook without first checking the formula to learn whether its derivation accorded with the conditions for which it was to be considered as applicable.

Qualifications

In a general sense, a designer must possess a vivid imagination coupled with the power of visualizing the objective; one who has a knowledge of shop limitations and is well versed in the qualifications of available construction materials. New developments come from the ability of the designer to apply sound engineering principles in novel forms of service. The insistent demand for economy in production, in many cases, has forced the designer to seek new forms of construction as well as better qualities in the materials to be used for the machines. Concentration, persistency and patience are essential to the success of a designer.

The "stooping over a drafting board" bogie has acted as a deterrent to many young engineers who undoubtedly would develop into high class designers. The experience gained in the design department gives one a better appreciation of the problems that must be met in the production program of any industry.

In some industries the development engineers always are selected from the machine design staff.

Procedure

There are several lines of thought which the designer should follow. First, an analysis of every known force (average and maximum) which may be met in the normal operation of the machine. Undue consideration of imaginative forces usually will result in badly proportioned machines. Second, the selection and arrangement of the materials to best resist the strains. A good designer will make use of those forms of cross section which are best adapted to carry the known loads with the least amount of material and labor in its manufacture. Third, the modification of the theoretical design to meet manufacturing requirements. So many advances and improvements have been made in the machine tool field that there are relatively few things that cannot be made in a well equipped shop but the cost of production must be considered where trade competition is to be met. Fourth, the design must be a clear representation of the designer's thought to the workman. A lack of required views or dimensions in a design usually causes delays and errors that should have been avoided.

Considerations

The design of a machine brings into consideration two viewpoints, namely, theory and production. From the theoretical standpoint, the machine must combine certain mechanical principles to produce specific results; from the production standpoint, the machine must be a practical development of mechanical ideas. The success of a machine will usually depend upon its ability to produce the article for which it is built with accuracy and celerity. Accessibility to the

various members, and lubrication of the rubbing parts are very essential to the life and upkeep of any machine.

The designer should strive to simplify suitable mechanical combinations to attain desired results, for in a general sense a simple machine is preferable to one which is complicated in its make-up. The items of cost, replacements and repairs should be considered seriously in the design. Present practice in machines of standard types tends toward interchangeability of parts, thus avoiding the necessity of carrying large stocks of repair parts. In the early days of automobile practice there seemed to be a desire on the part of each manufacturer to incorporate peculiar standards of screw threads and sizes of tires for his particular car, thus causing a serious inconvenience to the car owner in making simple repairs or replacements.

Object of Machines

Normal man does not willingly choose to do the things which require hard physical labor or infinite patience but seeks to devise ways and means to circumvent the necessity of such tasks. To move a large stone, man prefers to use a lever or other mechanical device as a substitute for physical exertion. To draw heavy loads, man first trained animals, then devised machines to accomplish these tasks.

The mental exercise required for the development of machines and devices to relieve man from the performance of tedious and irksome tasks produced the machine designer.

A machine must be capable of producing those things for which it was designed with accuracy and expedition. Ordinarily, a machine must justify its creation by a significant increase in or economy of production. In many branches of industry, a machine will not be seriously considered unless it can pay for itself within a certain limited period and this condition usually requires operation at the highest permissible speed.

Machine Materials

Metals furnish almost exclusively the materials from which machines are built although nonmetallic substances have certain desirable characteristics which are utilized for specific purposes.

Of the metals, iron is the most important because of its adaptability, obtainability and relatively low cost.

Much research work has been done within the past few years to learn more about the possibilities of combining various metals to obtain desirable qualities and information of value to the machine designer has been brought to light.

Iron both in the cast and refined forms has been the principal material used in machine construction because it lends itself to a wide variety of purposes and is more generously distributed by nature than other metals. Iron is rarely used in its pure form because it gains desirable qualities only by combining it with other materials and can be fabricated to meet those qualities by specifying the kinds and amounts of foreign materials required.

Design Practice

The designer of the present time is able to work under more favorable conditions than prevailed a few generations ago due to increased knowledge of materials and stress action, also due to the various improvements in machine practice.

The old maxim of machine design, "What looks right is right," came from long years of experience with qualities of materials and shop equipment prevalent in the past years also from the behavior of the machine in the performance of its task. This maxim is by no means obsolete at the present time because the experienced designer becomes accustomed to those proportions which have served him well and in many cases confirmed by well-established methods of stress analysis. Therefore, his sense of proportion is developed in a particular field of design and becomes somewhat intuitive in his design work.

In general design work, average stress values are commonly applied but there is no assurance that the material used will conform to the average because of hidden imperfections which often elude the tests and scrutiny of the inspector. These facts unconsciously influence the judgment of the designer who is reluctant to take chances which may reflect unfavorably to him.

When untrammeled by a suspicion of the materials with which he works and given a wide range in the selection of the materials, the designer will be relieved of much of the uncertainty of personal judgment and guess.

Factor of Safety

Due to the uncertainties in the structure and the loads that may come upon a material, great care must be exercised in the amount of stress used in the design. In order to safeguard against failure, a fraction of the ultimate strength is used. The factor by which the ultimate strength is divided to obtain the working stress is called the "factory of safety." The application of a suitable factor of safety requires sound judgment and a complete knowledge of working conditions. A factor of safety is determined by;—

(1) Inexpediency of using the full breaking strength of a material. At times a simple ma-

chine part is designed to break as a matter of safety to the rest of the machine.

(2) Hidden flaws and internal stresses. This includes blow holes, laminations, cooling strains, etc.

(3) Unforeseen and wide variations in load conditions.

(4) Fatigue of the material due to a large number of stress repetitions.

(5) Destructive action on the material by external agents.

(6) Poor workmanship.

If a doubt arises in the mind of the designer relative to the working conditions or the material used, then he should err on the side of safety. Materials of doubtful qualities should be safeguarded by ample safety factors. Acting under steady load conditions, a material of known characteristics may be stressed nearly to its elastic limit, a condition which undoubtedly occurs many times in screwed and in riveted fastenings.

In general, larger safety factors are used when the piece is cast rather than hammered or rolled due to the improved molecular structure resulting from hammering or rolling the material.

Live loads require larger safety factors than dead loads.

Repeated stresses require larger factors than steady stresses.

Alternations of stress action, from tension to compression or to shear also require larger factors than those of a steady character.

The magnitude of the safety factor to be used in any given case can only be given in a suggestive way because of the multiplicity of conditions that may arise.

There will be found differences of opinion among designers in the selection of a safety factor.

As a rule, the safety factor is chosen largely from the character of the stress action caused by the load which may be grouped under three principal divisions, namely, steady, varying, shock.

The following factors of safety are taken from reliable sources and can be used in normal design work. Dead load conditions have been omitted due to the infrequency with which absolute dead loads occur in machine practice.

MATERIAL	KIND OF STRESS		
	Steady	Varying	Shock
Cast iron	6	10	20
Wrought Iron	4	6	10
Steel (hard)	5	6	15
Steel (structural)	4	6	10
Timber	6	10	15

The values given in Table I have been taken from various sources and show average practice but should not be used if exact test values are obtainable.

Data on alloy steels will be found in the literature of the American Society for Testing Materials, also in bulletins of steel companies.

In selecting a suitable working stress for a material, the proper factor of safety should be applied to the ultimate stress.

Where values have been omitted in the table, data was lacking or the variability in the range of quality of the material was such that it would serve no useful purpose to quote the values given.

Stress Analysis

Preliminary to the discussion of stresses it will

Table I

Physical Properties of Materials

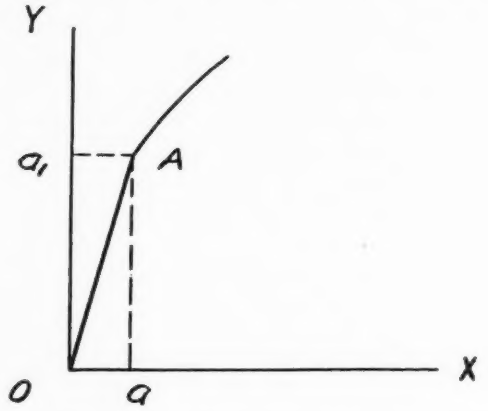
MATERIAL	WEIGHT	TENSION		COMPRESSION		SHEAR		MODULUS E	
	Lbs./cu. ft.	Ult.	Yield	Ult.	Yield	Ult.	Yield	Tension	Shear
Cast iron	450	15,000 to 35,000	....	80,000 to 125,000	....	20,000 to 30,000	....	15,000,000	6,000,000
Wrought iron	480	40,000 to 50,000	25,000	30,000 to 40,000	25,000	35,000 to 40,000	18,000	27,000,000	10,000,000
Steel (medium)....	490	60,000	30,000	35,000	30,000	50,000	21,000	30,000,000	12,000,000
Steel (hard)	490	75,000 to 80,000	38,000	40,000	38,000	60,000	23,000	30,000,000	12,000,000
Steel (3.5 nickel)	490	90,000	45,000	50,000	45,000	68,000	25,000	30,000,000	12,000,000
Copper	550	30,000	....	....	....	....	....	15,000,000	6,000,000
Brass	500	40,000	....	....	....	....	....	11,000,000	5,000,000
Aluminum	165	20,000	13,000	....	....	....	....	10,000,000	....
Timber	......	8,000	3,000	7,000	3,000	500 with grain 2,500 across grain			
Brick	......	....	....	3,500	....	500	....	2,000,000	....
Stone	......	....	....	8,000	....	1,500	....	6,000,000	....
Concrete	......	400	....	3,500	....	....	....	3,000,000	....

be necessary to define the meaning of various terms used.

Stress is the internal resistance to an external force or load tending to change the form of a body.

Strain is a change of form of a body and may be either temporary or permanent.

All materials are more or less elastic and there is a definite relation between the stress and strain for each material. This relationship can be shown by a stress-strain diagram, in which the stresses



are laid off on the Y axis and the strains on the X axis. Since the stress is proportional to the strain, the diagram shows a straight line and

$$\frac{stress}{strain} = \frac{Oa_1}{Oa}$$

and holds true up to a definite point for each kind of material after which the strain increases at a higher rate. In the diagram, the point *A* represents the limit to which the stress may go without causing a permanent deformation, for up to this point the material returns to its original shape *O* when the stress is removed. The point *A* is the upper limit of perfect elasticity of the material and is called the elastic limit. It is apparent that *A* represents the upper limit to which a machine part could safely be stressed. Elastic limit is the unit stress when the permanent deformation first occurs. The yield point corresponds closely to the elastic limit. Modulus of elasticity is the ratio of unit stress to unit strain. Ultimate strength of a material is the unit stress at which rupture occurs.

Simple Stresses

Forces encountered in machine practice are tension, compression and shear. Tension is a pulling force tending to elongate a body in the direction of the pull and induces a tensile stress. Compression is a pushing force, opposite in sense to tension, tending to shorten a body in the direction of the push and induces a compressive stress. Shear is the tendency of two opposite forces acting in parallel planes tending to cut a body into two parts and induces a shearing stress. A combination of forces acting at the same time induces compound stresses in a body.

When a body is subject to any one of the three stresses, the same general relations hold, namely: $P = S \times A$, in which P=load; S=unit stress; A=area of cross section.

The above simple relation does not take into account the strain or deformation, therefore the modulus of elasticity must be taken into account when the stiffness of a piece is considered.

Let, P=load; S=stress; A=area of cross section; E=modulus of elasticity; L=length of piece; e=strain or amount of deformation. Then,

$$e = \frac{PL}{EA}$$

This expression applies for both tension and compression by substituting proper values.

The value of the modulus of elasticity of steel is the same regardless of the quality, therefore all grades of steel acting under like stress conditions will be equally stiff under the same load but the strength will be determined by the stress value of each grade.

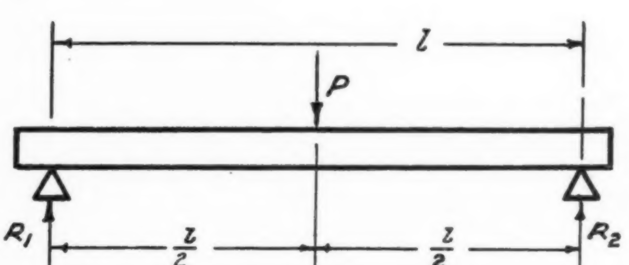
When a piece subjected to compression has a length greater than six times its diameter, the above formula does not apply for it is then considered a column and its stresses must be determined by column formulas.

Force Moments

The moment of a force is the rotative tendency of the force in its action on a body and is measured by the product of the force and the perpendicular distance from its line of action to the point about which it tends to rotate the body. If the effect is to produce bending in the body, the moment is called a bending moment; if the effect is to produce a twisting of the body, the moment is called a twisting moment or torque.

Bending Moments

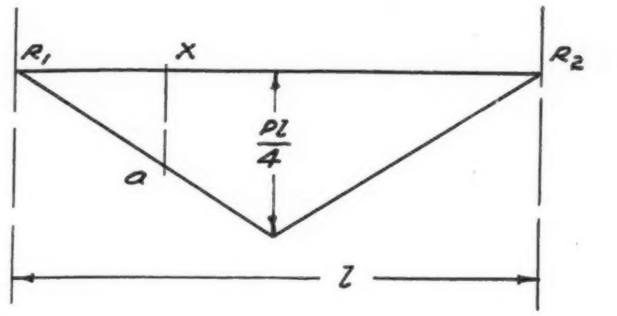
Consider first, a simple beam resting on two supports, thus,



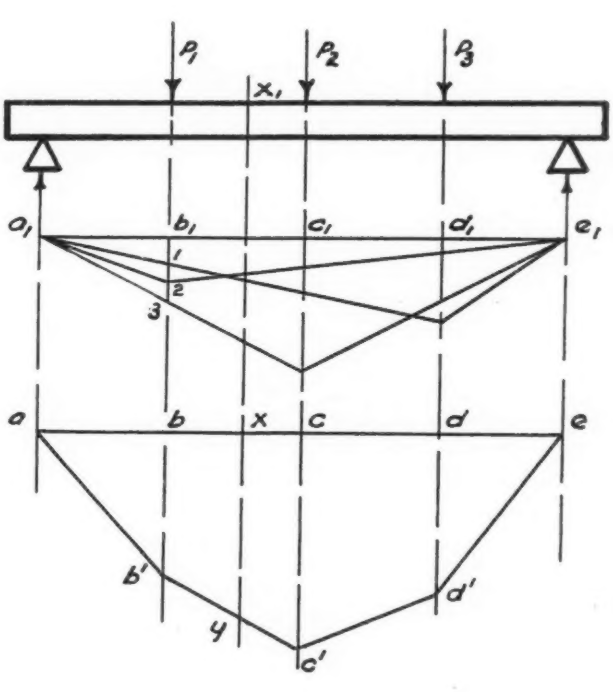
Neglecting the weight of the beam, the sum of reactions at the supports equals the load or $P=R_1+R_2$ and the maximum bending moment is

$$\frac{Pl}{4}$$

The bending moment diagram for this case can be shown, thus,



A graphical solution of a problem has a two fold value: first, it gives a picture of the conditions and second, it can be used as a check on a mathematical solution. To be of working value, the diagram must be laid out to a definite scale. The bending moment at any point X is aX. In case more than one force is acting on the same beam a bending moment diagram can be drawn for each and from these a combined diagram is constructed. In the combined diagram the bending moment for any section of the beam is obtained by taking the ordinate in the plane through the given point. For instance,

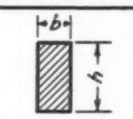
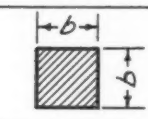
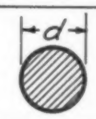
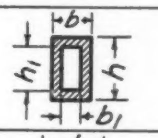
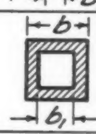
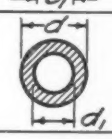
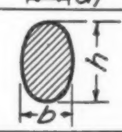


Points b^1, c^1, d^1 are located in the plane of the respective forces and at a distance below the reference line a to e equal to the sum of the ordinates found in the individual bending moment diagrams shown above, thus, in the plane of the force P_1, the ordinate b to b^1 is the sum of b_1 to 1, b_1 to 2, b_1 to 3. The bending moment at any point such as X_1 is X to y.

For every force acting on a member there is set up a resistance equal and opposed to the acting force; also for every bending moment there must be an equal resisting moment.

The resisting moment is made up of two factors, the stress and the section modulus. The stress value depends upon the material and the section modulus upon the geometric form of the member.

MOMENT OF INERTIA

SECTION	I-MOMENT OF INERTIA	Z-SECTION MODULUS
	$\frac{bh^3}{12}$	$\frac{bh^2}{6}$
	$\frac{b^4}{12}$	$\frac{b^3}{6}$
	$\frac{\pi d^4}{64}$	$\frac{\pi d^3}{32}$
	$\frac{bh^3-b_1h_1^3}{12}$	$\frac{bh^3-b_1h_1^3}{6h}$
	$\frac{b^4-b_1^4}{12}$	$\frac{b^4-b_1^4}{6b}$
	$\frac{\pi(d^4-d_1^4)}{64}$	$\frac{\pi(d^4-d_1^4)}{32d}$
	$\frac{\pi bh^3}{64}$	$\frac{\pi bh^2}{32}$

Section modulus is the term applied to the moment of inertia of a section divided by the distance from its neutral axis to the outermost fiber or

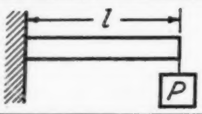
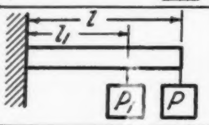
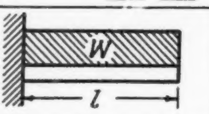
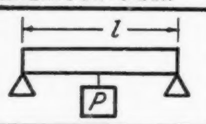
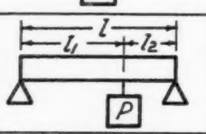
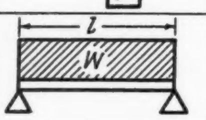
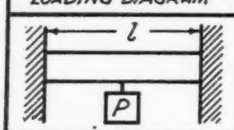
$$Z = \frac{I}{c}$$

in which Z = section modulus; I = moment of inertia; c = distance from neutral axis to outermost fiber of a section.

From foregoing considerations, the following general equation can be used for problems involving bending moments only,

$$Pl = S\frac{I}{c} \text{ or } M = SZ$$

in which M represents the algebraic sum of the bending moments. The condensed table of bending moments given on the following page includes only a few of the typical forms of loading.

CANTILEVER BEAM		
LOADING DIAGRAMS	M-MAXIMUM	f-MAXIMUM DEFLECTION
	Pl	$\frac{Pl^3}{3EI}$
	$Pl+P_1l_1$	
	$\frac{Wl^2}{2}$	$\frac{Wl^3}{8EI}$
	$Pl+\frac{Wl^2}{2}$	$\frac{l^3}{EI}\left[\frac{P}{3}+\frac{Wl}{8}\right]$
BEAM SUPPORTED BOTH ENDS		
LOADING DIAGRAM	M-MAXIMUM	f-MAXIMUM DEFLECTION
	$\frac{Pl}{4}$	$\frac{Pl^3}{48EI}$
	$\frac{Pl_1l_2}{l}$	$\frac{Pl_1l_2(l_1+2l_2)\sqrt{3l_1(l_1+2l_2)}}{27EIl}$
	$\frac{Wl^2}{8}$	$\frac{5Wl^3}{384EI}$
BEAM FIXED BOTH ENDS		
LOADING DIAGRAM	M-MAXIMUM	f-MAXIMUM DEFLECTION
	$\frac{Pl}{8}$	$\frac{Pl^3}{192EI}$
	$\frac{Wl^2}{12}$	$\frac{Wl^4}{384EI}$

Extended tables of bending moments will be found in standard handbooks also in steel company handbooks.

Torsion

Torsion is the effect produced by two equal and opposite couples acting in planes perpendicular to the axis of a member.

Torsion or twisting moment induces a shear effect and is found in the analysis of rotating pieces such as shafts.

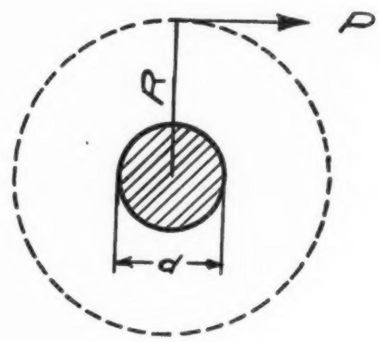
In the sketch, the force P acts at the end of radius R, tending to produce a rotation.

The resistance offered to torsion is found in the shear stress of the material and the section modulus derived from the polar moment of inertia. The equation therefore becomes,

$$PR = T = \frac{S\pi d^3}{16}$$

and letting

$$\frac{\pi}{16} = \frac{1}{5}\ (approx.)$$



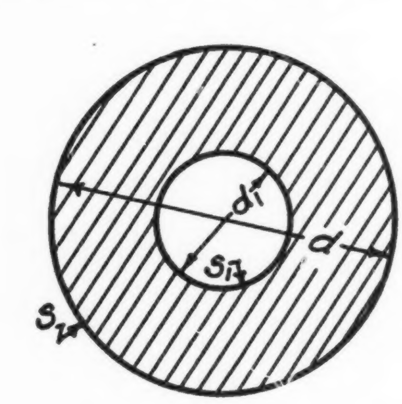
the general expression relating torsion, shear stress and diameter of a solid cylinder is,

$$T = \frac{Sd^3}{5}$$

Hollow Cylinder

The widespread use of hollow members, such as shafts, spindles and axles is due to the inherent advantages of this form over the solid type. The effect of forging and cold rolling on the structure of steel is to induce overstressing of the metal at the center of the piece. Moreover a hollow member is stronger than a solid one for the same weight of material. The cross section of a hollow cylinder forms an annular ring.

In the sketch, let d = outside diameter; d_1 =



inside diameter of the annular ring.

Solid cylinder,

$$SZ = \frac{Sd^3}{5}$$

Bore,

$$S_1Z_1 = \frac{S_1 d_1{}^3}{5}$$

Annular ring,

$$T = SZ - S_1Z_1 = \frac{Sd^3}{5} - \frac{S_1d_1{}^3}{5} = \frac{S(d^4-d_1{}^4)}{5d},\ since\ S_1 = \frac{Sd_1}{d};$$

or

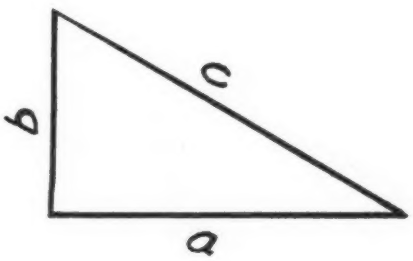
$$T = \frac{S d^3}{5} \frac{(d^4 - d_1{}^4)}{(d^4)} = \frac{S d^3}{5} \left[1 - \left(\frac{d_1}{d} \right) \right]$$

Combined Stresses

Rotating members of transmission machinery are frequently subject to a bending action together with torsion and in such cases the combined effect of the two forms of loading must be considered.

Bending takes place in the axial plane of the member and twisting in a plane perpendicular to the axis, therefore it will greatly simplify the solution of a problem if these forces can be directly set off on the perpendicular sides of a right triangle and the combined effect shown by the hypotenuse of the triangle.

There is a marked difference between the tensile and shear stresses of steel, therefore a relation must be established between the bending and twisting moments before they can directly be combined.



Referring to the sketch, the known relations between the sides of a right triangle can be expressed by,

$$C = \sqrt{a^2 + b^2}$$

Let M = combined moments; B = bending moment; T = twisting moment; then

$$M = \sqrt{B^2 + (KT)^2}$$

being a constant to be determined.

For bending moment only,

$$B = SZ = \frac{S d^3}{10}$$

and for twisting moment only

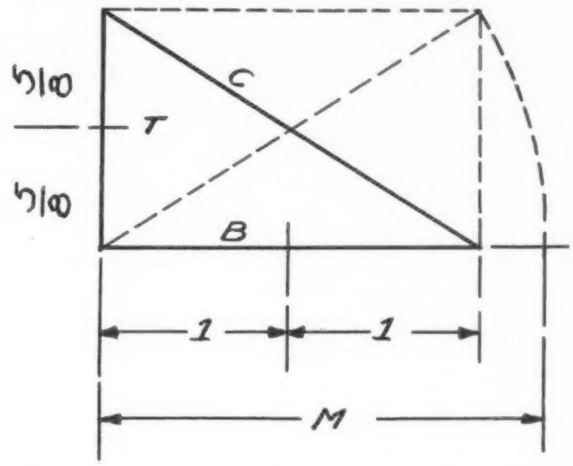
$$T = S_1 Z_1 = \frac{S_1 d^3}{5}$$

Equating the bending and twisting moments,

$SZ = K_1 S_1 Z_1$; *and since* $Z_1 = 2Z$, *assuming* $S_1 = 0.8S$ *for medium steel, then* $SZ = K0.8S2Z$, *or* $K = \frac{5}{8}$

This value of K will apply to the qualities of steel commonly used for shafts but in any case a suitable value for K can be found.

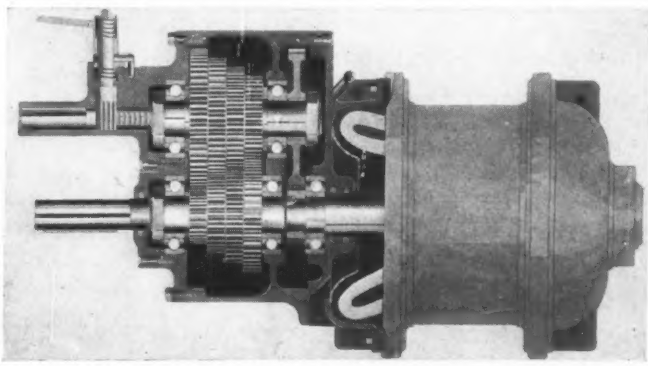
To apply this method for the solution of a problem, lay off the bending moments on the X axis to a given scale and the twisting moments on the Y axis to 5/8 of the given scale.



Since the combined moment is found in terms of a bending moment, it can be referred to the bending moment scale on the horizontal or "X" axis and read off directly. This method of solving problems involving combined moments will later be used for the determination of shaft diameters.

Variable Transmission Has Four Speeds

A multispeed transmission recently has been placed on the market by the Wise Mfg. Co., Berkeley, Calif. The transmission delivers four speeds in geometric ratio, and special speeds also



can be furnished up to 25 per cent above motor speed down to 280 revolutions per minute.

Speed changes can be made through a lever and any speed can be selected while the driven machine is in operation.

The unit consists of a casing into which the motor shaft projects. A pinion on this shaft is in constant mesh with a drive gear on the counter shaft of the transmission. The variable speed gears are keyed to the drive shaft, and in the countershaft gears there are internal clutches actuated by a mechanism which enables the desired speed to be selected instantly.

Whys and Wherefores of Gray Iron

By John W. Bolton

THE accompanying article on gray iron is the second of several by prominent authorities dealing with the application of castings and materials to machine construction, from the standpoint of the designer. Subsequent articles will deal specifically with other kinds of metals and will appear in forthcoming issues.

IN PAST years the gray iron foundry industry has been a laggard in encouraging application of technical methods. Fortunately, a number of wide awake foundry units have been an exception and have adhered to progressive policies to advance the art. The possibilities of proper and economical application of gray iron castings are more clearly understood than before. Methods of production of materials of exceptional physical properties have been worked out. However, only a little of this information yet is available to the designer, and it is hoped the lately-formed Gray Iron institute will undertake to furnish the information and actually promote further research.

In engineering design, the best material for any part is that which fully satisfies service requirements at lowest ultimate cost. As an engineering material gray iron has a number of unique and valuable characteristics. Among these are the following:

Gray iron easily can be cast into intricate shapes and light sections. It produces unusually sound castings with a minimum of manufacturing precautions.

Comparatively low shrinkage minimizing necessity of elaborate systems of gates and risers to avoid porous areas in castings.

Smooth finish and clean castings free from dross, pinholes and like defects, easily are attainable.

The material can be cast to close dimensional tolerances. Low cost castings are possible.

Tensile strength of commercial grades of gray iron varies from 20,000 to 40,000 pounds per square inch. Special grades are obtainable with strength up to 60,000 pounds per square inch.

The compressive strength is often about four times the tensile strength.

High modulus of rupture, up to 90,000 pounds, in transverse loading, is due to shifting of neutral axis and high compressive strength.

It possesses high brinell hardness compared to its ease of machinability.

Established properties are exceptional wear resistance and practical freedom from tendency to gall or seize, even at elevated temperatures.

Definite and rather high fatigue strength is shown.

Strength is retained to somewhat over 800 degrees Fahr. on short time tests.

It has the lowest specific gravity of regular ferrous metals and the brasses, tin bronzes, and nickel alloys. Its gravity is 6.9 to 7.2.

The material shows resistance to many types of corrosion such as caustic, concentrated sulphuric acid, etc.

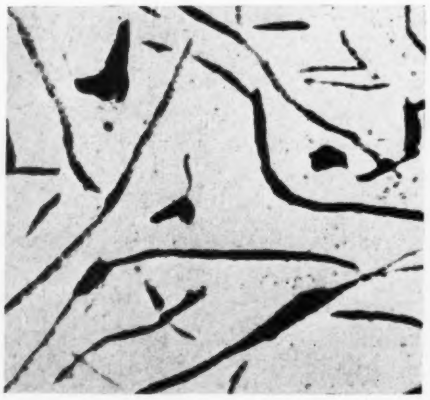


Fig. 1—Coarse graphite (black flakes) in weak gray iron. Magnified 100 diameters. Not etched

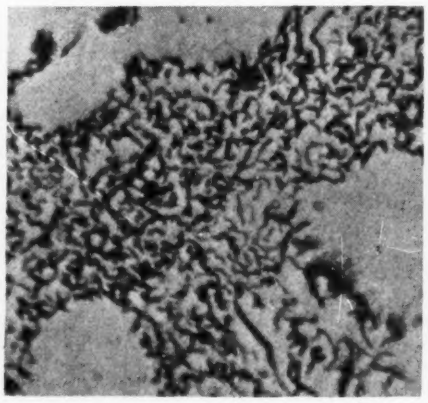


Fig. 2—Very fine graphite in gray iron. Magnified 500 diameters. Not etched

Fig. 3—Fractured gray iron. Graphite flakes along fracture edges. Magnified 25 diameters

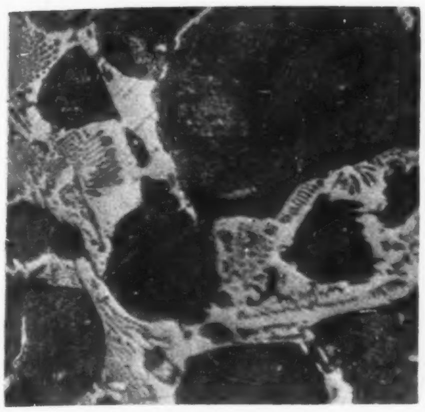


Fig. 4—Steadite (white honeycomb structure) in gray iron. Magnified 610 diameters, etched with picric acid

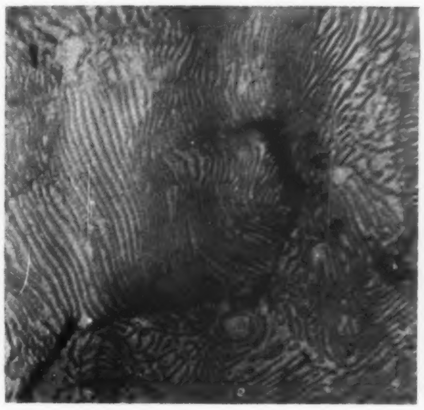


Fig. 5—Pearlite (laminated or thumb print structure) in gray iron. Magnification 2000 diameters, etched with picric acid

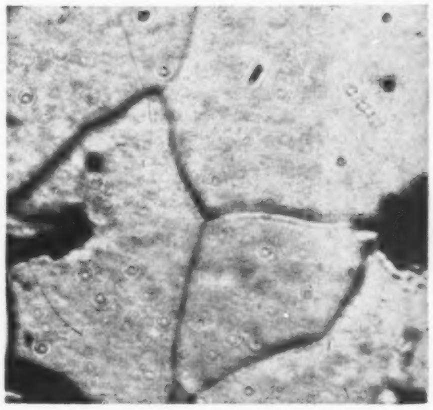


Fig. 6—Ferrite (gray white) in fine grained gray iron. Magnification 2500 diameters, etched with picric acid

Before discussing undesirable properties, it is well to note that many troubles attributed to gray iron have been due to selection of utterly improper grades for services intended. With proper information at his disposal, the designer will avoid misapplications. Gray iron is not one metal, it is a series of alloys of widely varying physical properties and the necessity for selection of proper grades is obvious. Furthermore, shop production executives sometimes insist on softer grades to get unduly high machine tool performance. Again in many cases design is not logical. In the old days of design of machinery, the cry was weight and more weight. Too little attention was given to securing rigidity by lighter yet stiffer members. Plenty of room for improvement along this line still exists.

Among the less desirable properties of gray iron is the comparatively low Young's modulus of elasticity. This is usually between 12,000,000 and 15,000,000 for the so-called secant modulus at 50 per cent of the ultimate strength. The Young's or tensile modulus of elasticity for all types of steel is almost 30,000,000. The alleged great rigidity of gray iron is mythical as it rarely possesses over half the rigidity of steel. The material has negligible ductility. This prevents fabrications by either cold or hot working. A piece of cast iron will break before distorting, whereas steel will give some warning by distortion before fracture. However, great ductility is a virtue of secondary value in most machine design.

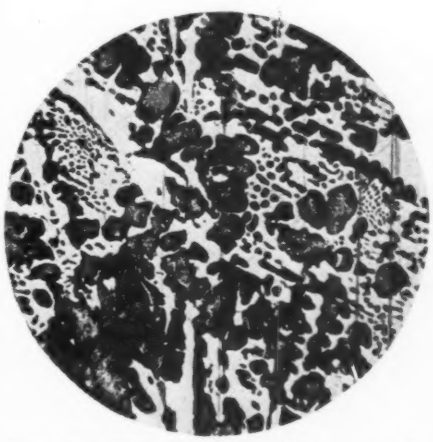


Fig. 7—White cementite areas in a chilled iron. Magnified 100 diameters, etched with picric acid

The impact value is low. In the absence of accurate data on this property, gray iron has received more condemnation than it deserves. Some of the better grade irons have fifteen times the shock resistance of inferior grades. A tough iron will stand an amazing amount of abuses before fracture. On this point—low shock resistance of improper grades of iron—many designs have been changed to other metals where the proper grade of iron would have proved satisfactory and far more economical.

Open grain or pitted appearance on machined surfaces occasionally is given as a detrimental property of all gray iron. There is no excuse for this, as such appearance is a certain indication that an inferior grade of metal is employed.

The occasional appearance of hard chilled spots condemns some iron castings. In very light castings it requires careful adjustment of mixture or use of alloys to avoid this trouble. In heavier castings there is no excuse for it, if logical metallurgical procedure is followed. Many old time foundrymen attempt to adjust the properties of their castings by control of percentage of silicon only, paying little or no attention to that important element, carbon. As a result they usually get a much more brittle and less machinable metal than is desirable. Their metal may pass the requirement for physical strength, but a material lower in carbon and higher in silicon would serve the designer's purpose much better and be more economical.

The growth of cast iron is a bugbear which has worried designers for many years. Under even moderate heat, particularly in presence of steam and of

certain mildly corrosive fluids some structures have been noted to grow or expand. This growth is accompanied by a great softening and weakening of the metal—sometimes it gets so soft that it can be cut with a penknife. Occasional appearance of this phenomenon has caused leading engineering societies to limit the applications of cast iron to 450 degrees Fahr. when employed in pressure-containing parts.

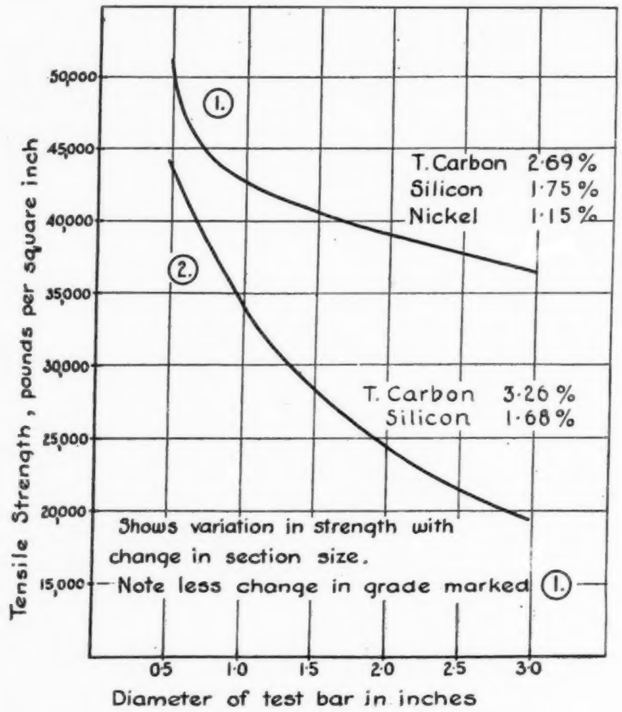


Fig. 8—Effect of cooling rate on various irons. Note that the lower carbon iron is much less affected by slower cooling rate

The total carbon of ordinary commercial cast iron usually runs between the limits of 2.90 and 3.70 per cent, the majority of common foundry grades being between 3.20 and 3.50. Silicon content ranges from 0.60 or 0.70 to about 2.75 per cent. Heavy section castings ordinarily have a lower silicon content. Phosphorus in cast-iron pipe, stove plate and like castings runs up to around 0.90 per cent whereas castings for severe engineering applications have a phosphorus content varying from 0.15 per cent to 0.35 per cent. Most foundry irons contain from 0.50 per cent to 0.80 per cent manganese. Sulphur may be 0.08 per cent to 0.12 per cent, in some cases as high as 0.15 per cent.

How Name Was Derived

Structurally, gray iron is composed of a metallic matrix in which are imbedded countless flakes of graphitic carbon. It is from the gray appearance given the fracture or break by these flakes that gray iron obtains its name.

If a piece of gray iron is polished carefully, then examined under the microscope, the black flakes are seen readily as shown in Figs. 1 and 2. These graphite flakes have little strength hence their presence weakens the metal. It is obvious that the greater the amount of graphite, the weaker the iron will be. Careful researches have shown that graphite affects the mechanical properties of the iron according to its *amount, distribution,* and *size.* Comparison of Figs. 1 and 2 make it quite evident that great differences are found in graphite flake sizes of various irons. Also as shown in Fig. 3, fracture tends to follow along the graphite flakes, since these furnish paths of minimum resistance.

Large flakes break up the metallic matrix most effectively, hence are most detrimental to strength. They also indicate unfavorable conditions of cooling, and often are a sign of too high total carbon or otherwise improperly balanced analysis. The pitted appearance of notoriously poor grade, open-grained irons is due to the tearing out of coarse flakes. These flakes are seen easily by the naked eye, some being over 1/16-inch long. If the machinist rubs his hand over the surface of such a casting his hand becomes black and shiny, just as from the graphite, lead, of a soft pencil.

No Pitting Is Apparent

Fine grained irons show no pitting visible to the eye, and blacken the hand comparatively little when it is rubbed over a clean freshly machined surface. Graphite is about a third the density of iron so a small per cent by weight means a large percentage by volume.

The total carbon in gray iron occurs in two forms, the graphitic carbon noted and cementite or so-called combined carbon. Cementite is a

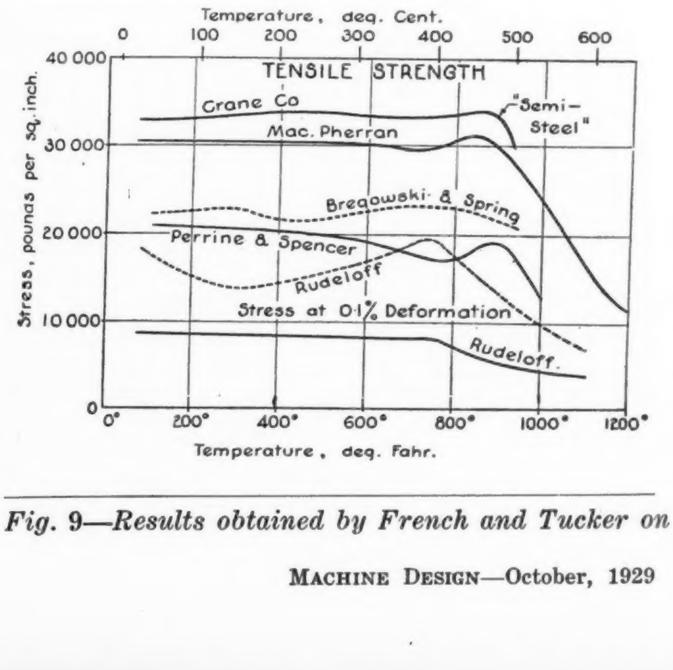


Fig. 9—Results obtained by French and Tucker on shor

chemical compound, an iron carbide having the formula Fe_3C. It is intensely hard and brittle. It is found in cast iron in two forms. As massive cementite it forms a large part of mottled and white or chilled cast irons (Fig. 7). The great hardness of these irons is well known to engineers. When the combined carbon is 0.70 or less the cementite is found in thin lamellae between lamellae of ferrite (structurally carbon-free iron.) This laminar structure, illustrated in Fig. 5, is a eutectoid, called pearlite.

Pearlitic Matrix Is Present

Pearlite is found in carbon steels and in nearly all gray irons. It is strong and moderately hard, about 200 brinell. Where greatest strength is desired, irons low in graphite and of pearlitic matrix are employed. Most high strength irons and the so-called pearlitic iron exploited by the Germans fall into this classification. While the majority of commercial high strength irons have a pearlitic or nearly pearlitic matrix, the converse is not true. Pearlitic irons of high graphite content are not strong, and they are harder to machine than irons with less graphite and pearlite and of equal strength.

The third structural component of gray irons is ferrite, structurally pure or carbon-free iron, shown in Fig. 6. As is the case of pure iron, ferrite possesses moderate strength and a brinell hardness of about 100. Gray irons low in graphite with a matrix composed largely of ferrite can be made with good strength and high machinability. They are too soft for best wearing properties.

The phosphorus in gray irons occurs in the component known as steadite, shown in Fig. 4. Steadite is hard and brittle. In large amounts it imparts its brittleness to the iron and tends to lower machinability—being particularly detrimental to tool life. Automotive cylinder blocks which have very thin sections around the water jacket often contain under 0.20 phosphorus. The writer has had experience with high and low

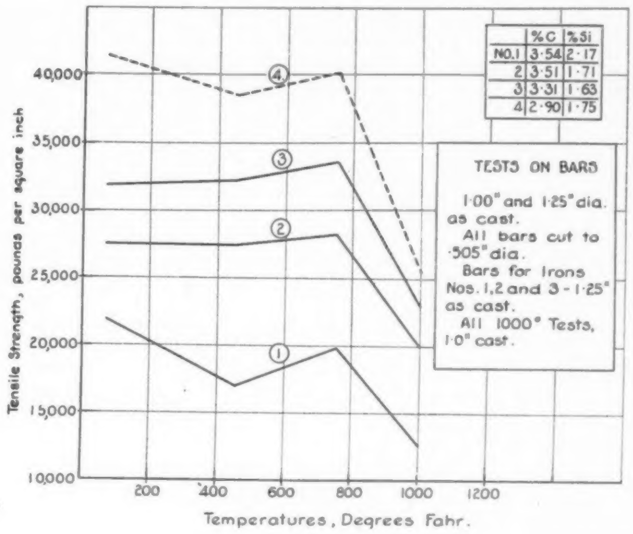


Fig. 10—Results obtained by J. W. Bolton on short time tests of gray irons at elevated temperatures

phosphorus in castings ranging from 100,000 pounds in machine tool work, to small engineering castings down to a fraction of a pound. With the exception of thin plate work phosphorus at 0.25-0.30 is sufficient to run 3/16-inch sections in nearly all designs.

Silicon is an important element in that it has a pronounced effect on the relative amounts of graphitic and combined carbon in iron of given total content. Without silicon, all alloys of iron and high carbon (over 2.2 per cent) would be white irons. Addition of enough silicon makes them gray irons. Since it is a graphitizing agent, too much silicon tends to weaken irons.

Manganese, in the amounts usually found in foundry iron has little effect. When trying to produce a chill, as on a car wheel tread or on a chilled iron roll, the manganese sulphur ratio is important and influences the depth of chill.

Sulphur Is Not Detrimental

Years ago blowholes, shrinkage, open grain and other defects were blamed on high sulphur. Careful investigations have revealed that these fears were greatly exaggerated, and castings of 0.12 or even 0.15 sulphur often prove quite satisfactory.

In the period from 1900 to 1920, oxygen was blamed for many then mysterious evils encountered by the metallurgist and founder. Most of

	Chemical Composition, per cent						
Investigator	Combined Carbon	Graphitic Carbon	Total Carbon	Mn.	Si	P	S
*MacPherran	....	....	....	0.64	1.84	0.52	0.11
Bregowsky and Spring	0.17	3.31	....	0.60	2.57	0.73	0.10
†Perrine and Spencer	....	....	2.69	....	....	....	....
¶Rudeloff	....	....	3.56	0.93	2.64	0.52	0.05
‡Crane Co.	"Semisteel" or "ferrosteel"						

*Test pieces annealed at 1100 degrees Fahr.

†Curve based on few tests.

¶Averages from wet and dry sand castings.

‡Low carbon cast iron with high manganese, low silicon.

time tests of gray irons at elevated temperatures

this oxygen trouble was mythical and the real trouble was lack of scientific research.

The cooling rate of an iron casting has much to do with its physical properties. Slow cooling increases degree of graphitization and increases grain size. Therefore, in iron of given analysis slower cooling means lower strength and hardness. Since the cooling rate depends on section size, it is obvious that the composition of the iron must be selected to give best results for a given section size, or at least for a range of sizes. Extremely light and heavy sections—whether in different or the same castings—should not be cast from the same iron if uniform quality is to be maintained throughout. The desirability of uniform section in design is obvious.

The writer ran into a case where a strong iron was needed and the foundryman claimed he was producing it. Tests from sections of the casting showed about 15,000 pounds tensile. One test is worth many opinions. Some foundries, using special processes, consistently can make irons of 50,000 pounds, and occasionally running up to 65,000 pounds tensile. Such irons are very useful in certain applications. Yet universal usage of high strength irons is neither necessary nor desirable. Often an iron of reasonable strength will meet all the service demands with an ample safety factor and be more economical.

Most tensile test figures given in gray iron literature are obtained on separately cast test sections ranging from ¼ to 2 inches. As shown in Fig. 8 some irons are much more affected than others.

The wear resisting properties of gray iron are unusual and perhaps too little appreciated. First, gray iron has high brinell hardness in comparison to its easy machinability. Locomotive cylinders, automotive cylinders and diesel cylinder liners are examples of severe service satisfactorily performed by gray iron castings. Recent research by N. L. Mochel throws light on the exceptional resistance of gray iron to seizing or galling, even at elevated temperatures and high pressures. In his experiments he compared various steels, stainless steel, monel metal, nitrided steel, gray iron and other metals. The gray iron samples showed no tendency to seize or gall, either running on themselves or on the other metals with which they were placed in contact.

The writer recalls quite vividly an experience in heavy machine tool design. An experienced designer, familiar with the good wearing properties of gray iron, had arranged for a heavy steel bar to work through a gray iron sleeve. Pressures were high. The iron wore well, but there was some slight cracking away at one end of the sleeve, as no relief was provided. Bronze was substituted and it squeezed out of shape. Hardened steel plates were used and bad wear was encountered.

The previous considerations mentioned are related to metal to metal wear. Where abrasion

Fig. 11—*Showing how graphite flakes in gray iron are covered over by grinding. Magnified about* 100 *diameters*

Fig. 12—*Showing metal (not gray iron) galled by heavy pressures. Gray iron resists galling, even at elevated temperatures*

bars, usually on the so-called arbitration bars, 1.20 inches in diameter. The properties of gray iron are influenced by change in cooling rate to a greater degree than are those of most metals. Gray iron becomes lower in strength as cooling rate is retarded, or as section size increases. This lowering in strength usually is most marked in

is encountered harder metal, such as chilled iron, is preferable. Wire drawing and erosion are resisted by the close grained irons.

The fatigue resistance of gray iron has been studied by Moore, Kommers, Lyon, and others. Definite fatigue limits have been established, usu-

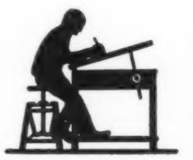
(*Concluded on Page* 36)

Organization and Supervision of Design Department

By John F. Hardecker

Part II

Scheduling Design Work—Systematizing Sections—Practical Aspect of Standardization



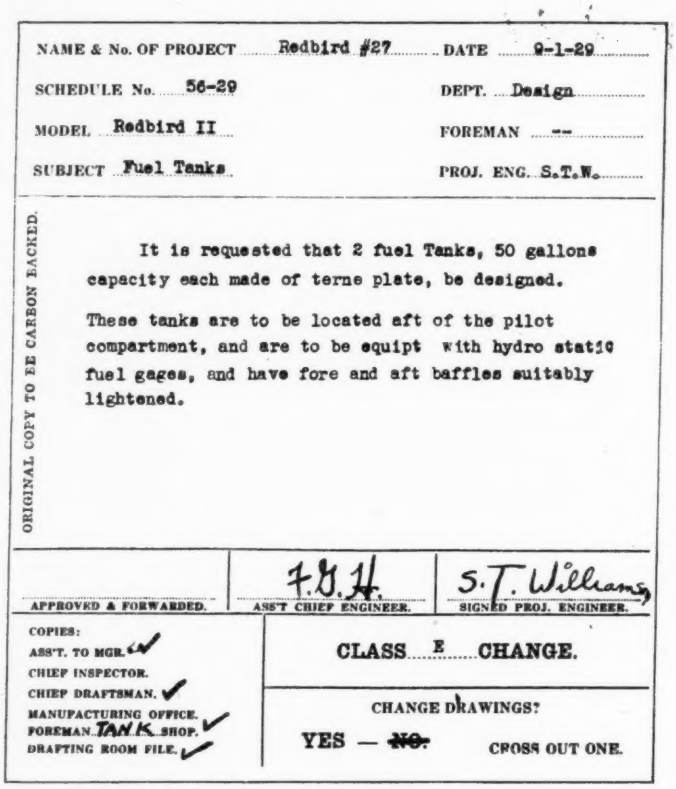
IN ORDER for a design department to attain its maximum utility, it is essential that it be systematized to increase efficiency and reduce overhead. This demands that functions be clearly defined, that regular routine channels for all action be established, and that the personnel be given specific assigned tasks. A procedure should be established for all normal or readily anticipated demands on the department, to be waived only through the medium of the chief draftsman, as far as the direct issuance of orders to personnel is concerned.

Authority to perform work in the design department should be receivable only in written form, or if verbal orders are absolutely necessary, they should be confirmable in writing. A prescribed form, such as the project engineers form shown in Fig. 1, signed by the project engineer and forwarded to the chief draftsman by the assistant chief engineer is highly desirable. All changes on drawings which have been regularly issued should be authorized only in this manner, unless they represent the correction of obvious errors of minor importance. Upon the receipt of the proper written authorization, the chief draftsman should route it, with additional instructions (verbal or written) if required, to the section supervisor assigned via the schedule clerk. The schedule clerk should record it in the follow-up folder of work to be done, and turn it over to the section supervisor for action.

IN THE first of this series of six articles by John F. Hardecker, chief draftsman of the United States naval aircraft factory, many points such as location and equipment, personal equipment, new men, etc., were discussed. In this and later articles other important features are dealt with. The next treats handling of new orders, freedom of design leaders, contact with production department and other vital matters.

While good design often is closely akin to invention, and obviously you cannot "invent by the clock," it nevertheless is true that the work of design can be carried out in accordance with predetermined schedules. These schedules are desirable not only to establish the truth of that age-old definition of an engineer "as a man who can do for one dollar (hour) what any darn fool can do for two", but even more so, in order that the work of the allied divisions of the organization, such as planning, production,

sales, etc., can also coordinate and chart their work accordingly. While for purposes of the engineering department records, a design may be considered complete when all the drawings and specifications on it have been issued, that design is not actually complete until it is successfully available for sale and utilization by the purchaser. Therefore if the other departments concerned in the carrying out of a project are to handle their work efficiently, speedily and according to schedule, "design dates" must be first established.


NAME & No. OF PROJECT Redbird #27 DATE 9-1-29
SCHEDULE No. 56-29 DEPT. Design
MODEL Redbird II FOREMAN --
SUBJECT Fuel Tanks PROJ. ENG. S.T.W.

ORIGINAL COPY TO BE CARBON BACKED.

It is requested that 2 fuel Tanks, 50 gallons capacity each made of terne plate, be designed.

These tanks are to be located aft of the pilot compartment, and are to be equipt with hydro static fuel gages, and have fore and aft baffles suitably lightened.

APPROVED & FORWARDED. | F.G.H. ASS'T CHIEF ENGINEER. | S. T. Williams SIGNED PROJ. ENGINEER.

COPIES:
ASS'T. TO MGR. ✓
CHIEF INSPECTOR.
CHIEF DRAFTSMAN. ✓
MANUFACTURING OFFICE.
FOREMAN TANK SHOP. ✓
DRAFTING ROOM FILE. ✓

CLASS E CHANGE.

CHANGE DRAWINGS?
YES — ~~NO.~~ CROSS OUT ONE.

Fig. 1—Sample form for authorizing new work or design changes

Therefore the schedule clerk should maintain under the direction of the chief draftsman, a complete schedule for all the personnel of the department, using some form of schedule similar to that indicated in Fig. 2. This form will not necessarily include the names of those who have a permanently assigned general function of a supervisory nature, but it should include all personnel available for schedule assignment.

Major Design Work Is Scheduled

On major design jobs, the schedule clerk should maintain in addition a complete schedule of the operations into which that job is divided and the personnel assigned to it, as indicated on Fig. 3. The full lines indicate the drafting time and the dotted lines the checking time allowed. Similar schedules may be advisable for the mathematical and checking sections. The operations into which a major job is advisable are so intimately linked up with the type of machine design involved that no definite rules can be offered. However, if a standardized breakdown can be established for certain types of work, it is distinctly worth while, not only for the purpose of maintaining comparable records, but also for controlling time estimates on similar jobs. Of course, good judgment indicates that there should be a reasonable amount of slack to provide flexibility in the total assignments of personnel, for contingencies are obviously better met by reassignment of personnel than by extending completion dates.

In order to establish better the relationship of the main producing part of the design department, which is the drafting section, with the other major sections, it will be advisable to first elaborate in more detail their particular functions. Only by definitely settling their duties can the drafting section itself be systematized for maximum efficiency.

Mathematical Section Prepares Calculations

The mathematical or analytical section prepares stress analyses, capacity calculations and all general calculations on major design problems for the drafting section during the process of design. Briefly, the mathematical section provides that essential analysis of a problem which will establish the definite trend of the design and at the same time preserve those calculations for permanent reference.

Where reports are prepared, each report should be assigned a serial number and the originals filed in the engineering files. A title block should be filed with the originals for each report. Copies should be bound in standard folders, with a blueprint of the title block pasted in the front of each folder, or else a folder with typed or printed title block used. Reports are best typed, carbon backed, on transparent paper, so that additional copies may be obtained readily by blueprinting. Each report should be made complete within itself, sketches, drawings, sections, stress diagrams, etc., being bound in the report and assigned page numbers. Letter size sheets are preferable, with larger sheets, if needed for tables or diagrams, of such shape that they will fold readily into the binder.

The first page of a report should be the title page with the title, report number and date appearing at the top. Below the title should appear a complete list of references. After the references there should be a list of tabulated data giving the specific conditions for the analysis or calculations. Summation sheets should be placed at the end of the report. After checking and approval, reports should be forwardable to the drafting section squad leader concerned, via the

chief draftsman. On rush work preliminary data may be furnished direct as the drafting work progresses, the final report being prepared as soon as possible.

Standards and Specifications Section

The standards and specifications section originates and develops standard parts and prepares working drawings covering these. It also prepares specifications in conjunction with the project engineers, covering the purchase and inspection of materials and specifications for manufacturing processes, heat treatments and finishes. It should further determine what items, either finished parts or raw materials, should be kept in stores as stock standards, and should recommend the initial high and low order points governing them. Where production work is to be done to customers' drawings, and it is not necessary to redraw, it should inspect these drawings and add the organization's standard part number and specification equivalents to these foreign drawings.

Standard drawings should be drawn with the maximum of information on them, conforming in general to the commercial practices existing in the industry from which they are purchased. They must be entirely complete within themselves, making no reference to other drawings or parts. Wherever possible, they should be in strict accord with the commercial parts of the industry from which they are purchased. Specifications should be written to conform to samples wherever possible, and in accordance with the commercial specifications existing in the industry from which the material is procured, and should avoid special tests wherever feasible.

The standards and specifications section is also a logical place to handle the contacts of the design division with the purchasing department, and the detail personal contact and technical correspondence with sales representatives and their organizations. The section is also a proper place for the initiation of substitution recommendations, whenever there is a shortage of specified material on urgent projects.

The drafting section prepares all drawings and bills of material, except on standard parts. The drawings must be made in accordance with mathematical calculations, standards and specifications and established drafting practice. A fundamental layout is the first requisite for drafting work, and should be made on a good grade of drawing paper, accurately drawn and to as large a scale as possible. This layout, being the backbone of the design, should be clearly and properly labelled to permit ready reference throughout the life of the project. Preliminary raw material lists, as requested by the project engineer, are prepared as an advance list of raw material for purposes of checking stores and ordering. The amount and nature of information required on drawings will be dependent on whether it is to be a production job, experimental job or shop-planned job, which fact should be established when the design work is authorized.

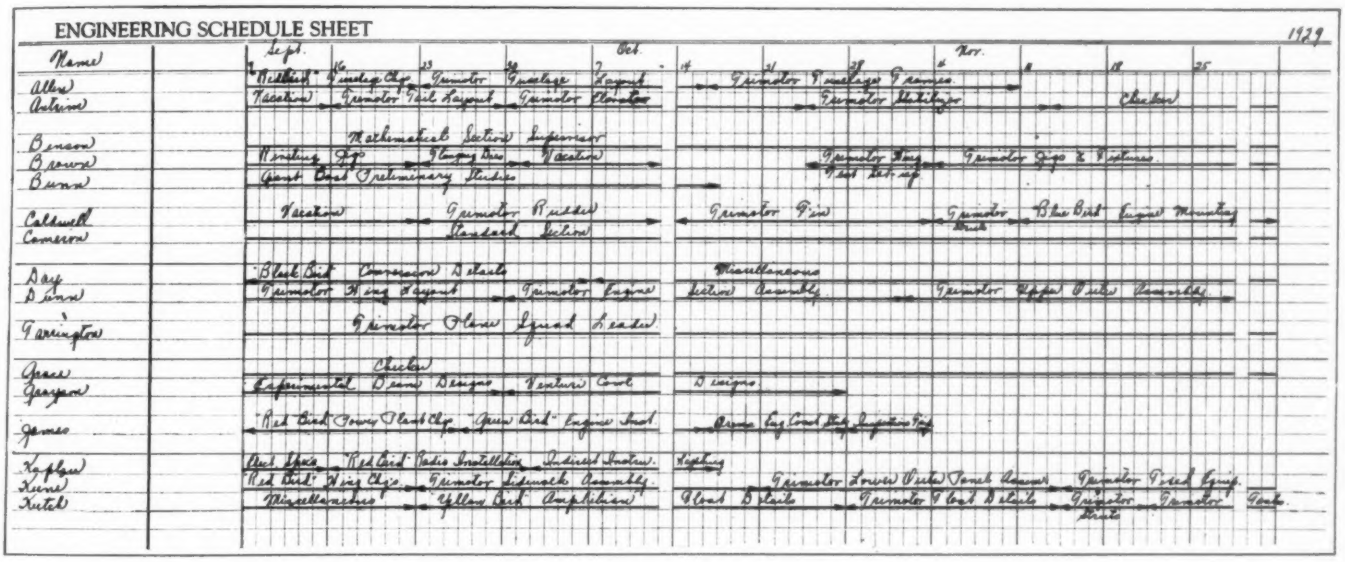


Fig. 2—Schedule form covering assignments of personnel

Transferring Drawings to Checker

Upon completing a given drawing, the draftsman prepares and delivers to the squad leader a list of reference prints together with a check print of the completed drawing. The squad leader, after proper inspection, delivers these to the chief checker, giving him at the same time all verbal and written information concerning the job, including the scheduled completion date, so

that the drawings may be expeditiously checked. On experimental work, the drawings of experienced men who have thoroughly established their reliability, may be released on occasion without checking.

All checker's corrections and changes should be made by the draftsman who originally made the tracing, both the draftsman and checker agreeing to the changes before the drawing is changed. If agreement on changes cannot be reached, reference should be made to the chief draftsman for a decision. After the checker's changes have been made, the check print and tracing are again submitted to the checking section for recheck and signature. The tracing is then ready for the approval of the chief draftsman and project engineer, after which it is issued.

The checking section checks all mathematical calculations for fundamental and detailed correctness, clearness and conformance to general specifications, and all drawings for function, strength, fits, clearances, tolerances and adherence to general specifications. Mathematical calculations and drawings are furnished the checking section in the form of check blueprints, together with a list of all references. Correct material may be marked with a yellow pencil, incorrect with a red. Where a considerable correction is to be made, it may be drawn in pencil and encircled with a red line, or referred back to the draftsman for detail revision before proceeding with the completion of the checking. All check prints are returned after checking to the squad leader concerned or to the mathematical section supervisor. When changes have been made, the originals are rechecked for correctness and signed. Reference prints are returned to the engineering files and check prints placed in the check print file immediately after signature of the tracing.

In the normal functioning of the drafting and standards sections the duties of the designer, detailer and tracer fall into natural channels. Similar in function, but often differing in title, are the work of the associate engineer, assistant engineer and junior engineer in the mathematical and specification sections of the design department. The work of the checking section is usually accomplished by designers.

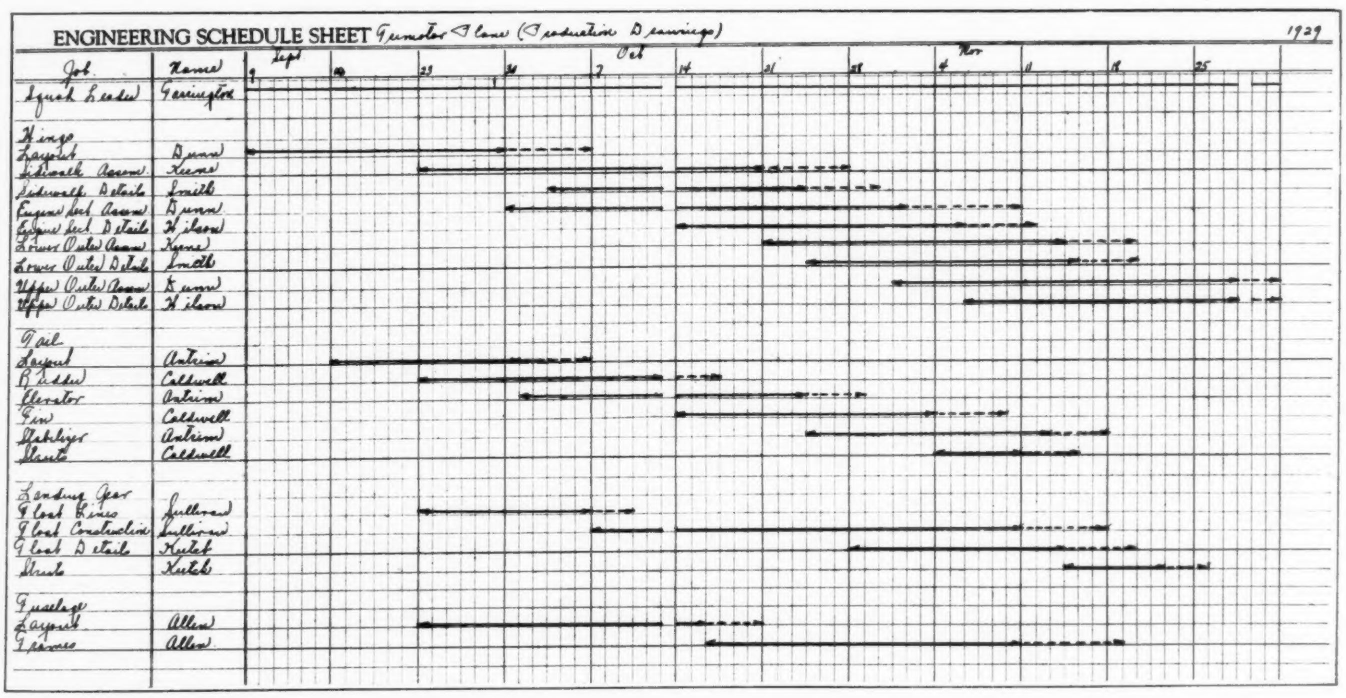


Fig. 3—Sheet for major design jobs. Full lines show drafting time, dotted lines checking time

Where production work is the order of the day, and ink tracings represent the ultimate form of design expression, the subdivision of work is clear cut and concise. The designer lays out the fundamental design on detail paper, the detailer develops and details and the tracer traces them. Where the work is experimental in character, or where direct pencil tracings on pencil tracing cloth represent the finished product, the fields of endeavor are not so clearly established, and there is bound to be a certain overlapping.

It has been stated concisely that the essence of good management may be summed up in three words, "organize, deputize, supervise." While the first and the last obviously involve the major functions of good management, the middle one, merely because it represents the far more simple

axiom, is not to be minimized in its significance. Deputizing, or assigning personnel properly to their work, is a most important task of the executive. As far as it is consistent with the general character and volume of the varying work in a design department at any given time, designers, detailers and tracers should be given work in accord with their title. However, to retain full flexibility in a large engineering organization with its varying ramifications of work, it is often advisable to shift personnel regardless of the title they bear. The important thing is that on every job assigned, the man should clearly know what his function is to be—whether that of designer, detailer or tracer, or their equivalents.

After all, a man's capability for advancement can be established best by practical demonstration. A good tracer should be allowed to detail on occasion, as well as a detailer should be permitted to do minor design work. After all, there are two things any design department employe can get out of his job, namely "money and experience." Merely because the permanent balance of the organization does not rate any more men of the higher qualification at a given moment, is not a good reason for depriving a detailer of design experience, on the grounds that he cannot be given the money of that rating at the particular time. Not only does this greater flexibility aid the organization as such, but it is beneficial to the man and his chances in the organization. When higher rated positions open up, there is not as great a temptation to go outside the organization to fill them, for this flexibility has brought out men in the engineering department who have shown themselves capable of the greater responsibilities. Whatever the degree of flexibility, one fact always holds good—every man should have a definitely recognized supervisor on every job—even though on special assignment it may be the chief draftsman himself.

Standardization Is Aid to Design

Standardization, or simplification as it is often called, when properly devised, controlled and applied, is an invaluable aid to good design. It eliminates from consideration those constantly recurring design problems which without standardization would permit of infinitely variable solutions, and allows full attention to be applied to the really significant and original factors of any major machine design problem. To appreciate the full usefulness of standardization to industry, we must broaden our consideration to encompass its effect on the entire industrial problem.

Briefly summarized, the principal advantages occurring to the machine manufacturer from standardization are as follows:

1. Permits the manufacture or purchase on a mass production basis, resulting in a reduced cost.
2. Concentrates on a lesser number of sizes and types, thus encouraging improvements in methods and costs that will utilmately reduce waste and reduce cost.
3. Encourages wider competition through a standardized product.
4. Permits parts manufacturer to carry stocks, and reduces the stock necessary to be carried by the machine manufacturer.
5. Permits parts manufacturer to stabilize his production and employment, and manufacture for stock in slack periods.
6. Reduces drafting work on design as standard parts may always be referred to by part number.
7. Facilitates interchange of parts on machines manufactured by different manufacturers, reducing the stock necessary to be carried by operators for replacements.
8. Facilitates replacement and emergency repairs by making parts not stocked procurable from nearest jobber or commercial distributor.
9. Coordinates and simplifies all design data and permits the creation of charts, graphs, etc., to facilitate design.
10. Makes available commercially many raw materials for the machine manufacturing industry, where otherwise the demand volume on a multiplicity of slightly varying specifications would make the cost highly prohibitive.

As a direct illustration of standardization, a company using a number of machines of different manufacture, would face the situation where a simple little 1/16-inch diameter ½-inch long commercial cotter pin, would have some 20 or more different part numbers, since each manufacturer gave it his own number, and sometimes even gave it different numbers on his own different models. Of course, it is not difficult to recognize that these are all the same, but it is an aggravating situation just the same. But, when we find the same thing true of engine bolts, with many types of alloy steels specified by different manufacturers, variation in threaded length, head thickness, tolerances, etc., the question becomes highly technical, and substitutions become a matter of engineering investigation. Proper standardization eliminates all this difficulty, and stocks only one given size for each type under a recognized part number.

All standard information is best issued printed, as photostats, or in the form of blueprints of

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Effective Methods of Lubricating Antifriction Bearings

By Harry R. Reynolds

THE purpose of this article is to bring out methods of lubrication especially suitable for speeds of 4000 to 7500 revolutions per minute which is about the range of present-day woodworking spindles. Either grease or oil can be used with favorable results if a few simple conditions are met, and among the manufacturers of ball bearing-equipped woodworking machinery both methods are in successful use—and here the author would advise that if machinery comes equipped for oil lubrication not to try out various oils, but to use the one recommended by the manufacturer of the machinery, who has spent time and money in experimenting. The same is true of grease. Not all grades of oil are satisfactory, neither are all the greases which might be handy. In fact the selection of the right grease is more difficult than the selection of the right oil.

The functions of a lubricant are to protect the surfaces of the balls and races from rust or corrosion, to aid in keeping out dirt and water, and to reduce friction between balls and separators. This is a simple list, but one which requires carefully selected lubricants.

The oil or grease must be neutral, as any acidity would etch and ruin both balls and raceways. This immediately eliminates the animal and vegetable oils and greases as they develop acidity with age. Neither should solids such as graphite, talc, and pumice be used as they fill up the raceways and are one cause of rupture of both rings and races. Either oil or grease may be used, but the conditions of use restrict us in our selection. This must be made after a careful study of the type of closure, accessibility, size of bearing, speed of rotation, and conditions surrounding the application. Where the user will give thought to his bearings and follow instructions, either system is successful. Unfortunately, present operators of woodworking machinery do not do this in the majority of cases, and so a fool-proof job becomes a necessity.

Housing Design for Oiling

Fig. 1 shows a patented device which is an ideal arrangement for oil. There is an ample reservoir in the housing, with a wick feed. This insures, when the right oil is used, a constant feed of clean oil. Fig. 3 also is a circulating system in which the oil level is established by the use of an oiler so placed that it will overflow outside before the inside oil level is too high. The oil is raised to the bearing in this system

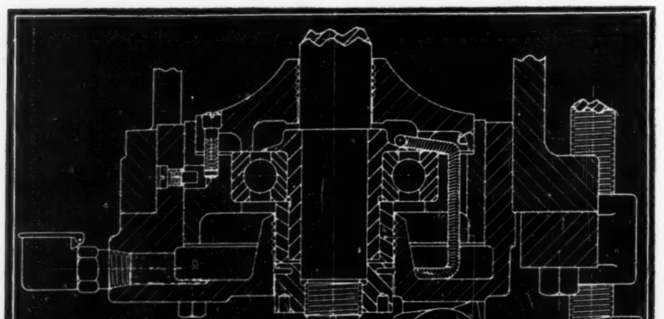
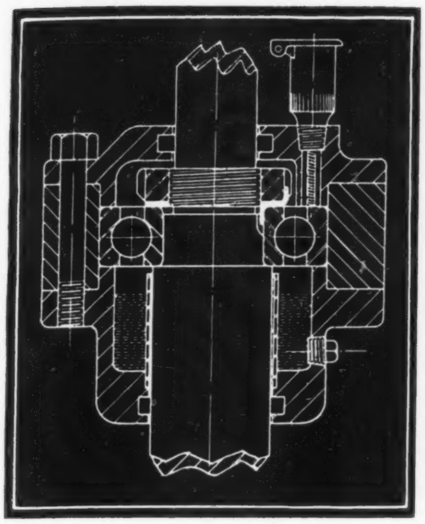


Fig. 1—Ball bearing housing with wick feed and ample reservoirs for oil

Employment of Antifriction Bearings Is Increasing

BALL and roller bearings are used to a large extent for high-speed shafts. Their adoption has occasioned considerable study to be given to the provision of satisfactory means for lubrication. This article, which is an abstract from a paper presented at a recent meeting of the American Society of Mechanical Engineers covers some of the methods employed, and includes valuable information on the uses of oil and grease. The author of the paper is chief engineer of the Fafnir Bearing Co., New Britain, Conn.



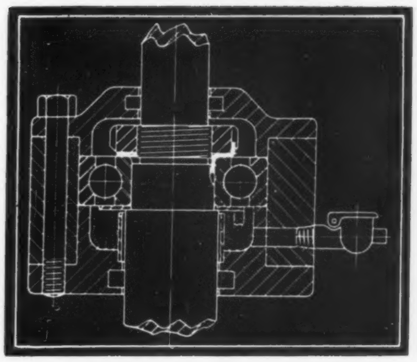
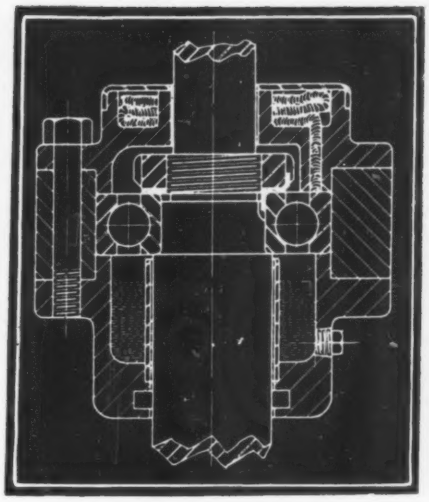


Fig. 3—Housing in which the oil level is established by cup
Fig. 2—(Left)—Vertical bearing equipped with a wick feed
Fig. 4—(Right)—Another type of vertical bearing with wick feed



only when the shaft is turning, as it depends on the projecting nib of the steel washer to lift the oil. Here also no filtering takes place, but due to the depth of reservoir and the fact that only the top oil is used, service with this arrangement is quite satisfactory. Figs. 2 and 4 show a wick feed arrangement which has the objection that the oil requires daily renewal as it passes through the bearing into the lower well, and must be drained out as the well fills up.

Fig. 6 shows a simple shield which is used successfully and which prevents the churning of oil in a horizontal application where circulation of oil by pump or wick is not quite so convenient as in the vertical application. Here the only oil which is subjected to churning from the ball movement is that between the balls and the steel disks at each side. The closer these steel disks are to the bearing, the less oil there is to churn. It is generally necessary, however, to mount them in the housing or clamp them between the inner ring of the bearing and the shoulders on the shaft, as very few bearings have space enough to allow their application directly in the bearing as shown.

Housing Design for Grease

Figs. 5, 7, and 8 show well-worked-out designs for grease application. In each case it should be noted that the grease is fed direct to the bearing and that the well for surplus grease is larger. Here a simpler design is possible, the grease being fed into the housing as required and the surplus removed when necessary. Fig. 7 shows a vertical application. The slinger under the upper bearing is all the seal that is necessary to prevent the grease working down into the motor. The same type of slinger over the lower bearing keeps the dirt collected in the motor from working through into the bearing housing.

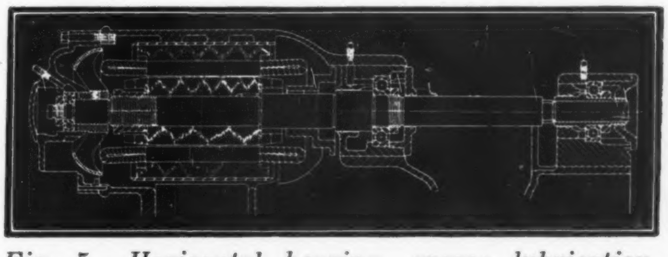


Fig. 5.—Horizontal bearing, grease lubrication

Figs. 5 and 8 are horizontal applications. The grease is kept in the housing by means of small grooves, and because of the fact that the grease works into the grooves, the seal is superior to felts which at the speeds of woodworking spindles tend to carbonize. The company with which the author is connected, in making recommendations for woodworking spindles, advises the use of an outside slinger seal, as shown at the upper part of Fig. 7. This is desirable both with oil and grease.

Advantages and Disadvantages of Oil

Any system of oil lubrication where the oil is either circulated or frequently renewed tends to keep the bearings constantly flushed out, and a ball bearing kept free from dirt is a long-lived bearing. The disadvantages of oil are due mostly to the fact that it is difficult to keep it in the housing. Any housing design which has an oil level high enough to allow the balls to rotate in the oil permits churning to take place. This causes heat, which thins the oil still further. The resultant vapors follow the air currents and work out of the housing, this constant leakage requiring that the oil be frequently renewed. To prevent this leakage and to feed oil to the bearings without their being submerged in it, requires a complication of parts which are costly. A further disadvantage of oil is that except when running, the bearings dry off and in this

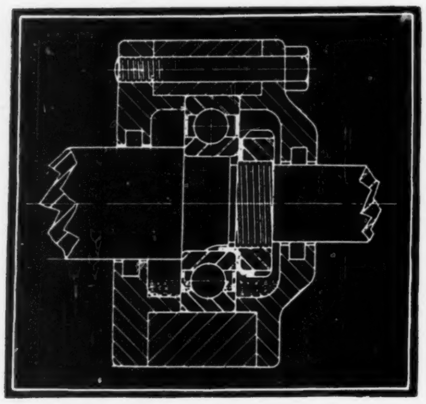


Fig. 6—Bearing in which churning of oil is prevented by a shield

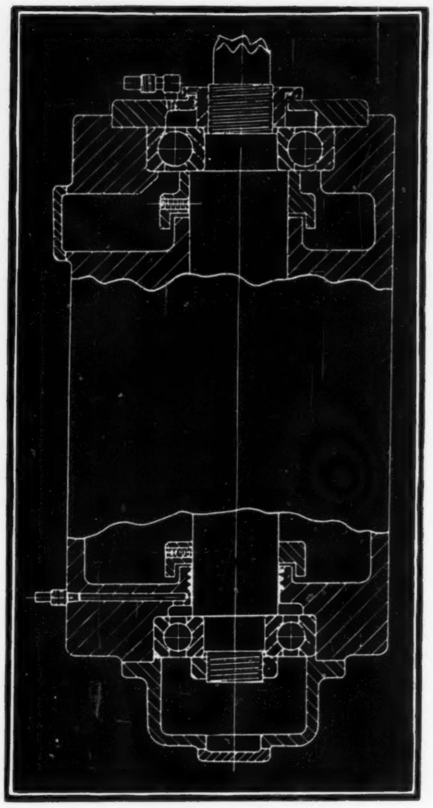


Fig. 7—Vertical bearing designed for grease lubrication

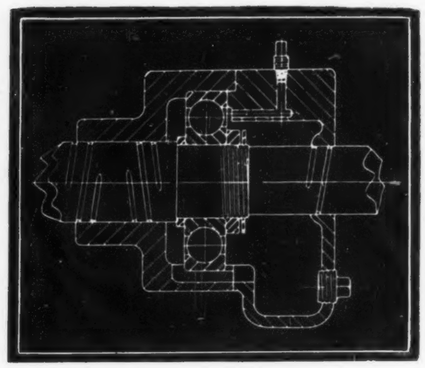


Fig. 8—Horizontal bearing designed for grease lubrication. Note retaining grooves

condition are exposed to rust.

Grease, if properly selected for the service does not work out of the housing, simplifies housing design, helps to seal the housing, requires less frequent renewals, is cleaner, with modern equipment is as easy to apply as oil and it will work in any position. All grease, however, is not suitable. A grease is not necessarily good because it has a nice color, feels slippery, and has a pleasant odor. There are many greases which after standing tend to harden. When others are exposed to heat sufficient to melt them the oil works out and leaves the filler. It is even more important that the proper grease be used than the proper oil. Fortunately, there are many satisfactory greases which can be used for lubrication.

The greatest disadvantage of grease is that dirt and grit mix with it, which converts the grease into a lapping agent. It does not flush out the bearing as will oil. Therefore, if dirt gets into grease, more rapid wear will surely follow. If balls and raceways break down, it is due to either overload or cramp. If cramp, the ball track on the raceways will not run true. If the bearing is badly loosened, this is because dirt has got in and lapped down the balls and races.

Organization and Supervision of Design Department

(Concluded from Page 31)

standardized size bound in a loose leaf folder. This will include sheets covering materials, parts (purchased or made), tolerances, unit strength values of materials, formulas, etc. Because of their extreme significance, and the fact that they must remain reasonably permanent if faith in their use is not to be destroyed, complete and thorough investigation and check is essential before the acceptance and issue of any standard.

Standardization can be abused. It is not a panacea for all ills, and must be applied and utilized with discretion. So handled, it will minimize its interference with the true design mind. Where a distinct advantage is to be gained by designing a special part in lieu of a standard part on a particular installation, there should be no hesitancy in doing so. While it has been claimed that a man often applies the standard tolerances for example to a design where much greater leeway might be permitted, it may be said with equal reason, that the same man without standards to guide him, might even unthinkingly add even closer tolerances of his own conception. The standard applied without judgment, will generally average better results than the careless design of the same individual, since the standards represent the best average or composite design condition.

In conclusion, while standardization has its faults and pitfalls, these best can be avoided by keeping constantly in mind the true meaning of standardization. The best definition known is that "standardization is common sense applied to creative individualism for the purpose of achieving the greatest good for all." Unfortunately, it is human nature to take a positive stand either for or against on any new issue, but in standardization at least, the best position is a reasonable middle ground.

Adjustment Is Vital Factor in Chain Drive Performance

By Ralph Dyson

ONE of the secrets of success in silent chain drives is the employment of suitable means for adjustment. Designers have the choice, for normal drives, of many methods which will be covered in Machine Design from time to time. In this article the author, special engineer with Link-Belt Co., describes one of these methods and the device used.

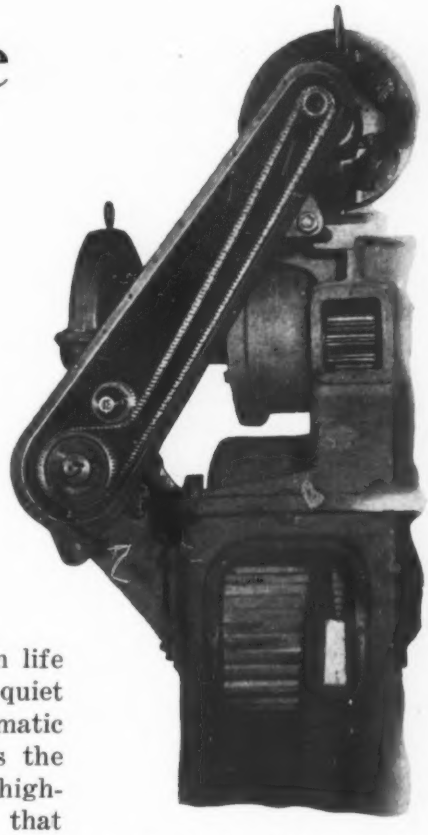


Fig. 2 — Automatic adjustment device can be used on the back of the duplex silent chain

DESIGNING and manufacturing on a production basis of the automatic adustment for silent chain drives probably was engendered as a cure for a perfectly natural illness that comes, in time, not only to every silent chain, but to every movable bearing; namely, wear. The accumulation of wear in a chain, quite reasonably, causes it to lengthen. However, this wear

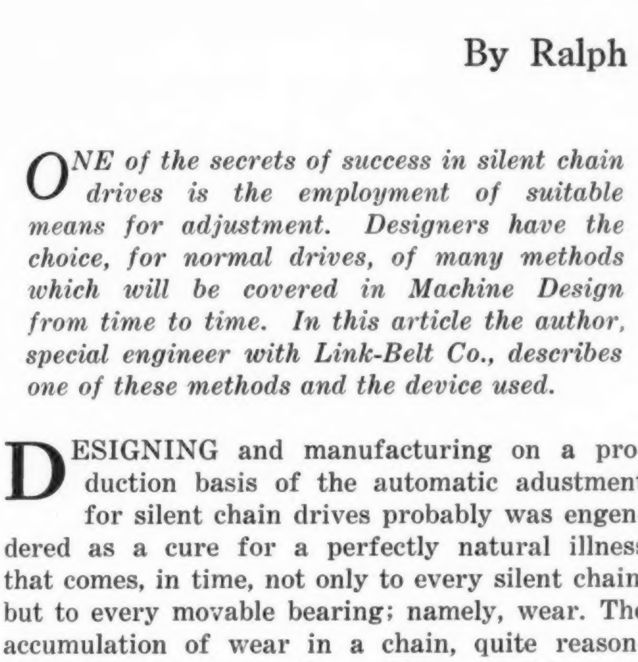


Fig. 1—Details of the automatic adjustment showing eccentric bushing, coiled spring, etc.

and lengthening is a slow process and is easily controllable by one of several simple methods.

With the correct use of idlers, the inherent difficulties of the silent chain drive are eliminated. Manually adjusted and automatic idlers have been employed successfully on both the inside and back of the slack strand of chain.

The feature of the automatic adjustment is that it not only takes care of any elongation that develops in the chain in service, but that it ensures, also, longer chain life and sustained quiet operation. Automatic adjustment saves the chain from the high-inertia strains that are likely to be set up when lost motion exists between shafts. Considerable influence, also, is exerted by the automatic adjustment as a vibration damper.

The device shown in Fig. 1 consists of the idler sprocket *A*, mounted on the eccentric bushing *B*, so that it can revolve freely. The eccentric bushing, in turn, is mounted on the stationary shaft *C*, and its motion is under control of the coiled spring *H*.

As the chain becomes slack, the spring *H* causes the eccentric bushing *B* partially to revolve, causing the idler sprocket to move in a direction that will take up the slack. Two spring-actuated plunger pieces *D*, acting as pawls, are in constant engagement with the ratchet plate *E*; so that when the eccentric bushing has revolved a distance equal to pitch of the ratchet, the bushing is held against any backward movement. As further slackness occurs in the chain the operation is repeated, thus automatically maintaining the chain in proper tension.

Chain drives with automatic idlers can be applied to all styles of machines operating from motors as large as 25 horsepower. In some cases

more than 25 horsepower can be transmitted with this drive. Some of the methods of application are shown diagrammatically in Fig. 3. A straight, vertical chain drive, as at *A*, is used on some machines; but this arrangement has no provision for keeping the chain in proper tension and contact, except by taking out one link after enough wear has occurred to require its removal. The same drive equipped with an automatic idler is shown at *B*, in which case the proper tension is maintained throughout the life of the chain. In this instance the idler is enclosed within the path of the chain drive, as will be noted.

By using the duplex type chain, the toothed idler can be applied in contact with the back of the chain, as at *C*, Fig. 3. Also, where location and direction of motion of the driven shaft may make it desirable, it is practicable to drive in a reverse direction, as with spur gears, without the limitations of distance between shafts required by gears.

In applying the automatic idler there are no

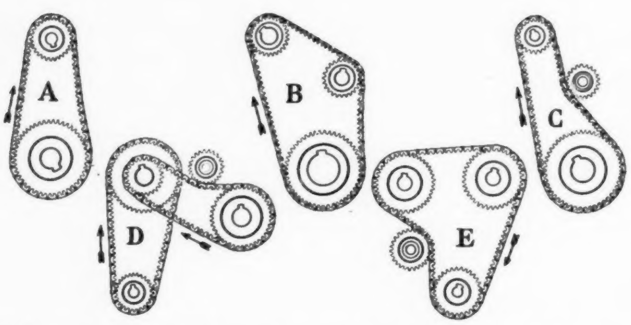


Fig. 3—Typical layouts of drives on which the adjustment is employed

changes required in the location of the driving and driven units. It is necessary only to provide a stub shaft for the idler to suit the style of drive to be adopted, such as shown in Fig. 2. However, it is good practice to encase the drive so it will operate in a bath of oil. Since the average application of a chain drive provides a contact over a large portion of the sprockets with which it meshes, sometimes being more than half the circumference, a smooth-running effect is produced. Then, if the chain can be held at a constant tension, a still smoother drive will result.

Microphotographs of work which had been ground on a machine on which both a plain chain drive, and a drive in which the tension was automatically maintained, were used, showed that the finish produced by the latter type of drive was considerably the better. Undoubtedly the automatic adjustment brings machines the same refinement of operation that it brought to the automobile front-end drive. It is well known that the vast majority of automobiles now use silent chain to drive the camshaft and accessories such as the generator, water pump, etc.

When the speed ratio is to be changed, it does not affect the idler. The correct wheels are installed and the chain is lengthened or shortened as the case may be. In putting the chain on, it is necessary to turn the bushing with its idler sprocket enough to allow sufficient slack or play in the chain. Then, as the machine is started, the idler will automatically adjust itself to the proper chain tension.

An idler can be installed in connection with either the prime mover drive or auxiliary drive, in accordance with the application.

Whys and Wherefores of Gray Iron

(*Concluded from Page* 26)

ally one third to one half the ultimate strength and roughly proportional to ultimate strength. Thus, no fear need be felt about alternating stresses if these are restricted to a reasonable percentage of the ultimate strength.

Up to some 800 degrees Fahr. good gray irons lose little if any strength as measured on short time tests. See Fig. 10. At 1000 degrees Fahr. gray irons have some tendency toward graphitization although this is slow. At 1200 degrees Fahr. graphitization and consequent permanent weakening of the metal proceeds at a good rate, while over 1300 degrees Fahr. it is rapid. Growth in gray iron arises from two causes. One graphitization, requires high temperatures, as indicated. However the second cause, internal corrosion, is more dangerous since less understood by engineers. In open grained irons the paths along the graphite flakes are nearly continuous. Hence gases and liquids can seep into the metal through these tiny orifices and set up internal corrosion. The condition somewhat resembles intercrystalline corrosion in other metals.

The facts are that properly made irons have given successful and continuous service with moderately superheated steam and various fluids in stills, autoclaves, acid eggs and many other places which demand resistance to growth. Irresponsible and ill-informed manufacturers are responsible for the comparatively rare cases of growth over which so much discussion has been centered.

Gray iron is a reliable and up to date material of construction. By careful selection of proper grades the designer can improve products economically. As time clears up certain at present obscure points the uses of gray iron castings are quite likely to be extended rather than restricted.

Employing Practical Suggestions For Laying Out Cams

By Fred B. Jacobs

FEW machines are built on which cams of one form or another are not employed. Information concerning them, therefore, is welcome to designers. In the accompanying article the author treats cam design from the purely practical aspect, and makes many pertinent suggestions. A subsequent issue of Machine Design will contain a further article on cams, dealing with the technical aspect of this important subject.

CAM motions are among the most useful movements at the command of the machine designer as they enable him to achieve desired results without the use of more complicated mechanisms. A cam can be called a contrivance for converting regular rotary motion into intermittent or irregular reciprocation and motion. There are endless varieties, many of special and complicated construction. The majority, however, are of the disk type wherein the path is generated on the side, if the cam is of the path type, and on the periphery if the cam is of the open type. Barrel cams also are commonly used. A barrel cam of the path type has the movement generated on the periphery while an open barrel cam has the motion generated on the side. These common types are shown in Fig. 1 wherein *A* is a disk cam of the path type, *B* an open disk cam, *C* a path barrel cam and *D* an open barrel cam.

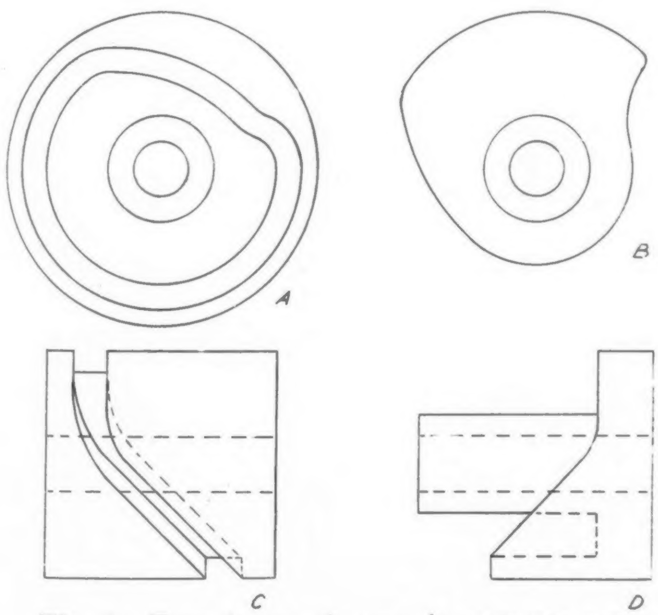


Fig. 1—Four types of cams in common use

Both open and path cams have their advantages and disadvantages. The open cam is easily constructed and permits sharp rises and falls, but the cam roll lever must be kept in place with a spring or weight. Path cams need no springs or weights to keep the roll in place as it is confined by its path.

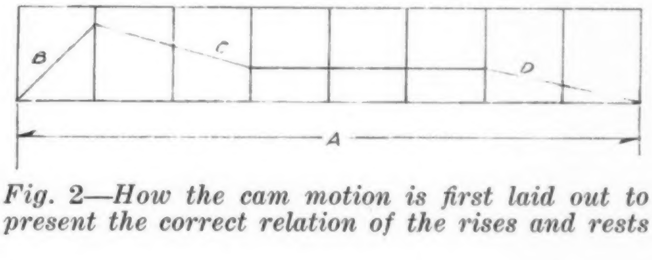


Fig. 2—How the cam motion is first laid out to present the correct relation of the rises and rests

Path cams do not permit as abrupt rises and falls as open cams, but they are capable of converting positive motion both ways.

The first step in the design of a cam is to consider carefully the work it has to do. This will influence the type, open barrel, path barrel, open disk or path disk. The next step is to determine just what the cam must do as regards motion. Let it be assumed that a disk path cam is wanted and that its motion must comprise a rise of $1\frac{1}{8}$-inch in $\frac{1}{8}$ of a revolution, a drop of $\frac{5}{8}$-inch in $\frac{1}{4}$ revolution, a rest of $\frac{3}{8}$ revolution and a drop of $\frac{1}{2}$-inch in $\frac{1}{4}$ revolution. With these data at hand, a chart such as shown in Fig. 2 is made. Dimension *A* must equal the circumference of an imaginary circle the center of which is the center of the master cam, and which passes through the lowest point of the cam path. It must be remembered that any cam motion when developed is simply a triangle in which the base is the duration of motion, and the altitude the

rise. The larger the cam the easier the rises. They are fixed dimensions whereas, as the cam is enlarged, the base of the triangle representing

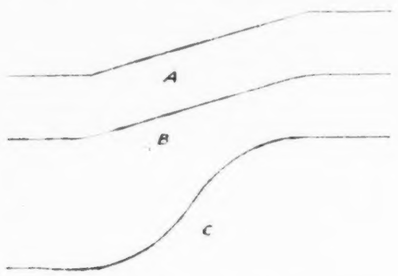


Fig. 3—Cam curves in common use

the motion becomes longer. On the other hand when the size of a cam is reduced, the rises remain the same, but the bases of the triangles representing the duration of motion become shortened. Thus a cam should be made as large as possible and in drawing the chart it should be borne in mind that the easier the rises, the smoother running will be the finished cam. An

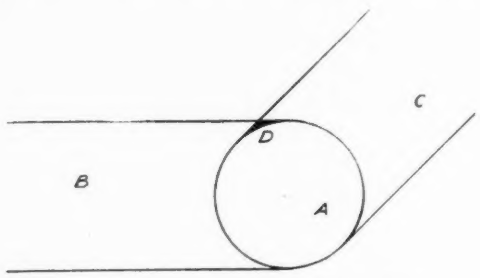


Fig. 4—Diagram showing how a cam path can be cut back

angle of 45 degrees as shown on the original layout at *B* Fig. 2 is about the limit for practical operation. However, in extreme cases more abrupt rises are permissible on slow-running cams.

Having in mind the diameter and width of the cam, which of course is controlled by limitations of the machine in which the cam is to operate, the next step is for the designer to inspect the cam-cutting equipment to ascertain the greatest

Fig. 5—Modified form of uniform rise

diameter permissible for his master cam. A master cam is made of brass, usually $\frac{1}{8}$-inch thick. From it are cut the cast iron leaders which in turn are used for guiding the motion in cutting the cams themselves. The designer is chiefly concerned with the master cam inasmuch as it is his job, where this system is followed, to generate the accurate outline on a disk of brass furnished by the toolmaking department. From the lines he generates, the toolmaker will machine and file the master cam to its correct shape.

Once the motion has been decided upon as shown in Fig. 2, the next step is to lay this out

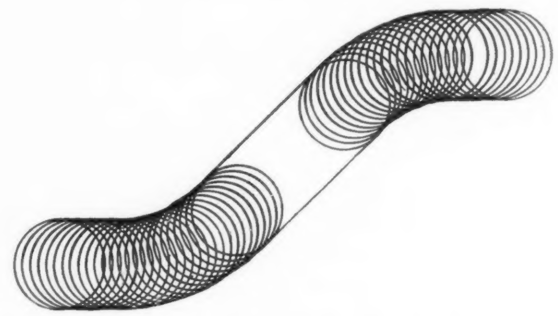


Fig. 6—Development of a cam motion showing the absence of cutting back

in a circular path on the brass leader. As the blank for the leader comes to the machine designer, it will have a hole bored and reamed in the center to slip over the cam cutter head arbor. A steel plug must be provided for this hole and a prick punch mark made in the exact center of this plug. The laying out of the motion on the brass disk will be explained later.

Referring again to Fig. 2, *B*, *C*, and *D* are sides of triangles. However, when laid out on the brass master cam they will be curves. This brings up the next important step, that of cam

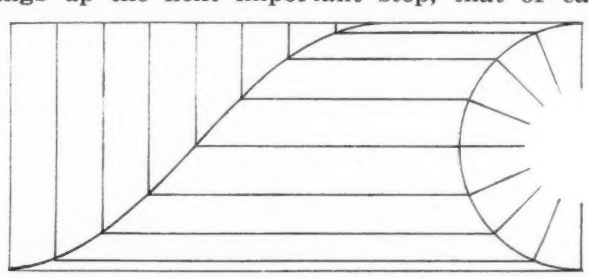


Fig. 7—A useful cam motion called the harmonic curve

curves. These are of three general kinds called the uniform rise, the modified uniform rise and the harmonic curve. They are shown in Fig. 3. The uniform motion is sometimes necessary, but it cannot be cut on a path cam. Thus if it is necessary it must be modified.

The uniform rise cannot be cut on a path cam due to the phenomena termed in shop language "cutting back." It may be well to explain this by means of the diagram shown in Fig. 4,

wherein *A* is a milling cutter that has just completed the path *B*. As the cutter cuts the path *C* it will cut away part of the groove shown by the heavy portion at *D*. Thus the cam roll would

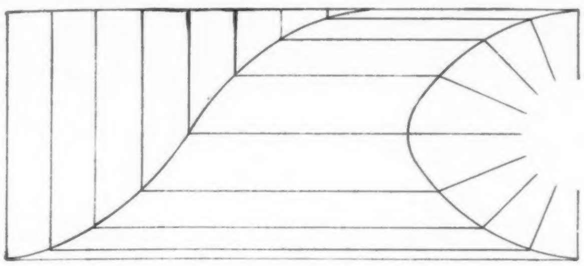


Fig. 8—Gravity curve sometimes employed on fast moving cams

not completely fill this path. To overcome cutting back we use the modified uniform motion. The radii of arcs *A* and *B* in Fig. 5 must be at least the radius of the roll that is to follow over the master cam. In Fig. 6 is shown how this works out in practice in cam cutting. A study of the drawing will show that this path is not cut back.

The harmonic curve is a useful motion. In Fig. 7 is shown a semicircle divided into eight equal parts. The diameter is the same as the rise of the cam. The line equaling the motion also is divided into eight equal parts and the cam curve passes through points where horizontal lines drawn from the semicircle and vertical lines drawn from the line of motion meet. This is a very easy cam motion and it is used frequently.

Another motion, for fast cams, is called the gravity curve. This is shown in Fig. 8. It is developed in much the same manner as the harmonic curve with the exception that an ellipse with major and minor axes having a relation of 11 to 8 is used in place of the circle. The stroke of the cam must be represented by the minor axis. This is a very useful curve and it can be incorporated into extremely fast moving cams with satisfaction. In designing cams it is always well to remember that cutting back must be considered in laying out every path cam, but it is of no consequence in open cams. Thus where uniform rises are necessary open cams must be used in place of path cams.

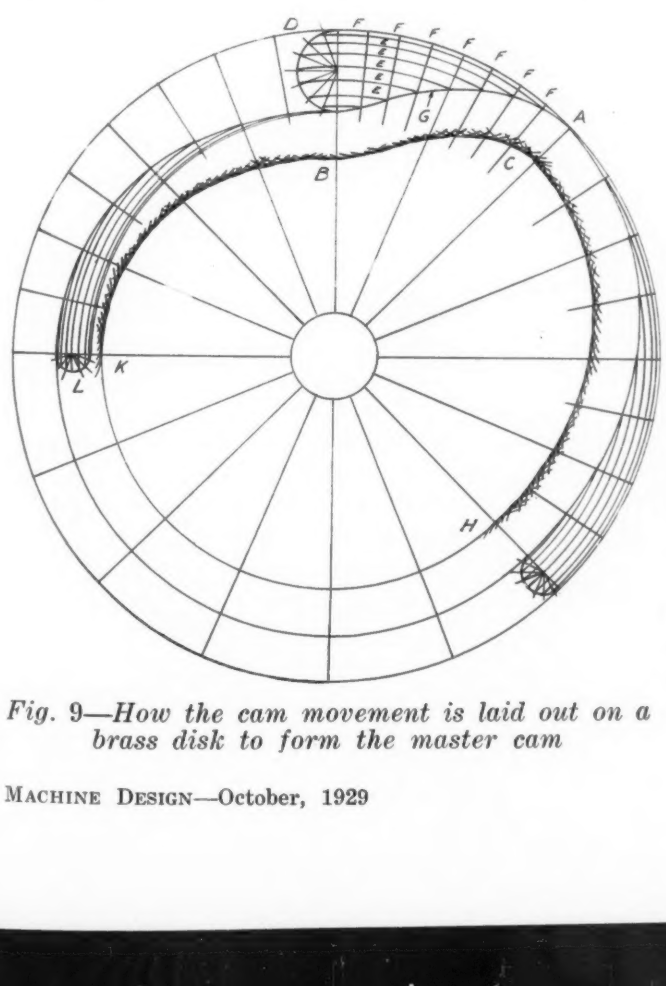


Fig. 9—How the cam movement is laid out on a brass disk to form the master cam

Fig. 9 shows the cam leader as laid out by the designer. The irregular line starting at *A* and continuing around the master cam is the cam motion and it represents the center of the roll that will be used in conjunction with this master in cutting a leader, which in turn is used for regular cam cutting. It is shown that the

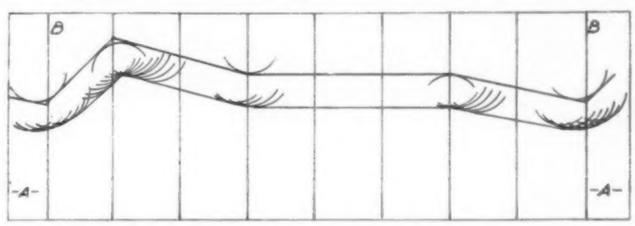


Fig. 10—Master cam for a drum type cam incorporating modified uniform rises

brass leader is divided into 16 equal parts by radial lines. Let it be assumed that the designer starts by laying out the motion between *B* and *C*, which corresponds to the rise *B* in Fig. 2. As this movement is for 1/8 of a revolution, it goes through two of the divisions made by the radial lines. To develop the harmonic curve the semicircle *D* is drawn and divided into eight parts, and from the radial lines the arcs *E* are drawn to meet intersecting lines *F*. Thus this is a harmonic curve laid out just as it was in Fig. 7 with the exception that in Fig. 9 it is laid out to accommodate the master cam on which the lines *E* are arcs instead of straight lines. Note that the cam curve *G* passes through the points where the radial and straight lines intersect just as they did in Fig. 7. The curve from *C* to *H* is laid out by the harmonic development at the right. From *H* to *K* is part of a circle, drawn in place readily. The curve from *K* to *B* is laid out from the harmonic development *L*. Remember that the line *A* is the cam curve while the line *C H K B* is developed to represent the path of the roll that will follow over the master cam when it is put to use. The radii of the little arcs shown which give the development, must always be just the radius of the roll that will be used in conjunction with the leader. This is important to

(Concluded on Page 45)

Consult the Parts Makers!

Editorial

ONE of the distinctive characteristics of modern American engineering practice is the increasing employment of numerous standard parts in machine construction. Under prevailing conditions engineers seldom find it necessary to design all of the details in new mechanical equipment. As a rule, items such as bearings, reduction gear drives, lubricating systems, etc., may be purchased from manufacturers whose experience in the application of their products is broad and dependable. Consequently, there is a feeling that it is not necessary to try to design a drive unit, for instance, if there are reduction gears on the market which suit the requirements in question. To design a special gear train under such conditions, it is felt, would be an inexcusable duplication and waste of effort.

But while these advantages of purchased machine parts are widely recognized, there are indications that not all builders of mechanical equipment recognize their responsibility in the employment of such parts. For instance, an automobile manufacturer who has relied to a large extent on purchased parts recently had considerable trouble with rear axles which were purchased in large numbers from a company specializing in axle construction. Investigation showed that the automobile builder had used a certain type of axle for one of his earlier models and that when his engineers changed the model by making it slightly heavier, extending the wheel base and making other alterations they assumed, without consulting the axle manufacturer, that the same axle could be employed in the new model. The cars were assembled on the basis of this assumption with the result that after they had been on the road a few months complaints regarding the rear axle began to filter into the office. The engineers of the axle company then were consulted and it took them only a few minutes to prove conclusively that the axle should never have been used on the new car. As a matter of fact, they indicated that if the automobile builder had simply exhibited his plans to the axle company, the latter could have provided an axle already designed and in production that would have served the purpose admirably.

Numerous other instances could be cited to emphasize the necessity of working out design problems with the manufacturers of the parts employed in machine design. In nine cases out of ten it will be found that the engineers who developed the purchase part have available precise information on the application of their product on machines which are similar to the one in question. If designers do not avail themselves of the opportunity to use the experience these parts engineers have gained, they are guilty of poor design just as clearly as if they had miscalculated the stresses in their machines.

Seldom Right First Time

WHETHER a newly designed machine should operate successfully on its first run is a question which sometimes arises in the minds of those not closely connected with design. Perhaps this is natural. In the viewpoint of these men the design department is given every opportunity to study earlier designs of related machinery, possibly a working model, the field in which the machine is to operate and other conditions surrounding the service to which the machine will be put. The information and data thus collected combined with the designers' technical knowledge, skill and experience may be thought sufficient to warrant the designing of a machine which will operate successfully without preliminary tests, trials or changes in its mechanisms.

Experience has proved repeatedly that this is not the case except in rare instances. Actually some of the best machines in operation today have undergone years of gradual development before arriving at their present state of perfection. And although they represent the best ideas of the day, they will become obsolete sooner or later as important improvements in design or entirely new designs are developed.

The cost of developing machines and improving upon the design as originally laid out sometimes is enormous; thus while in some cases this is inevitable every effort should be put forward to produce a machine that in its original form is as nearly perfect as investigation, study and human ingenuity can provide. This is the aim of every first class designer, and constitutes the line of distinction between mediocrity and excellence.

Archimedes and His Spiral Pump

Great Moments in Machine Design—Second of a series of original drawings prepared exclusively for this magazine symbolizing the designer's contributions to the progress of mankind

How Design Department Benefits from Contacts of Sales Staff

COOPERATION between executives of sales and design departments is essential to the success of any modern industrial business. Each can render invaluable service to the other. The sales department can bring to the design department information on field conditions and the general run of customer's characteristics; the design department can plan to furnish a product which will give the sales staff at least the opportunity to reach the goal—the goal being satisfactory profits from the sale of a satisfactory machine. However, in many cases full advantage is not taken of the linking together of these two vital branches of any company.

A barrier of this kind existed until recently between the two departments in a reputable company manufacturing printing machinery. Inefficiency prevailed to the detriment of good design and good salesmanship. Too much time was lost on both sides. The engineers of the concern created a printing press which to their minds functioned perfectly, but for some reason sales did not come up to expectations. Then came the demand from the management for a re-design. But the engineering department, due to its lack of intimate knowledge of conditions in the field was unable to put its hands on the roots of the difficulty. Several minor machine details were changed. Renewed efforts were put forward by the sales and advertising departments. Still the press did not sell, and it transpired later that though it was mechanically perfect for the particular work it had to perform, it was considered too delicate for the abuse met with in service.

Parts Had Passed Test

The circumstances surrounding this case perhaps were unusual. Those parts of the press which customers thought were too light had passed all individual tests required of them and had stood up under overload conditions in the factory tests of the machine. For this reason the design executive took a firm stand—which from the viewpoint of design probably was entirely justified—and created the impression with the company's directors that the press could not be improved. Consequently occasional reports reaching the design department from the sales staff to the effect that the machine was not considered suitable were discredited. Instead, such rumors and also orders for replacement parts were classified as "Troubles due to improper handling," and the blame laid on the user.

It was not until the sales and design departments consolidated their efforts in a thorough field investigation that desirable changes were agreed upon. Following the incorporation of these, every change made became a valuable talking point for the salesmen. Customer resistance on these points was eliminated and sales of the press were doubled within the next six months.

Sales Staff Is in Contact

Obviously the sales department, generally speaking, is in a much better position to judge the requirements of the market than is the design department. The sales staff necessarily must have implicit confidence in the designer's ability to produce a sound machine from the design standpoint. But, from contact in his territory each district manager knows, among other points liable to influence the sale of machines:

(1) Conditions under which machines operate.
(2) Competition to be met.
(3) Types of customers and their characteristics.
(4) Regional likes and dislikes of customers for the particular brands of manufactured parts incorporated in finished machines.
(5) The necessity of "educating" potential customers in acceptance of a revolutionary design.

Conditions under which machines operate are almost as varied as the industries in which machines are used. Manufacturers of machine tools are at an advantage in this respect because the operators and supervisors are themselves mechanics. Consequently better lubrication and better treatment are accorded machine tools than is the case with practically any other kind of machinery. For instance, machines are used in some industries in which women operators are em-

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Scanning the Field for Ideas

A Monthly Review of New Machinery, Metals and Parts, with Special Attention to Significant Design Features and Trends

FEW fortunate enough to be able to attend the recent National Metal congress at Cleveland could fail to be impressed by developments in the fabrication of new steels, rustless irons and alloys of various descriptions.

Most of these metals are employed in the design of machinery, or affect the design. Examples of materials in the latter category are the new tungsten carbide cutting alloys among which are Carboloy, Widia, Diamondite, Straus-Metal and Haystellite. Cutting speeds previously unheard of have been made possible by the use of these alloys. It has been demonstrated successfully that they will stand up to a cutting speed of 635 feet per min., on a cut 1¼ inches and feed of .01 inch. This was in cutting S. A. E. 1045 steel. Obviously more general rigidity is essential in machine tools, and other features have needed consideration. As Dr. Jeffries, consulting engineer with General Electric Co., said at a meeting of the American Society of Mechanical Engineers on Oct. 1, "Hundreds of thousands of dollars have been put into the development of machine tools to adapt them to the use of the new tungsten carbide tools." One of the developments is in the design of the bearings to prevent chatter and vibration, these factors being particularly detrimental to tungsten carbide tools on account of the tendency for the edges to chip. Other points are adequate lubrication of the bearings to enable economical cutting speeds to be obtained, rigidity of tool holders, the use of antifriction bearing-equipped tailstock centers, and higher powered motors to cope with the greater output of the machines. These and other features are rapidly being incorporated to provide machines that will enable maximum results to be obtained from the new alloy tools.

Among the New Materials

Stoodite and Borium, products of the Stoody Co., Whittier, Calif., were included in the materials featured at the exposition. Stoodite is a self-hardening alloy steel. It is produced in the form of welding rod and used for application by the electric arc or acetylene torch to the tips of rotary oil well drilling tools, steam shovel and dredger teeth, pulp mill knives, etc. Recause its base metal is iron it is said to amalgamate thoroughly during welding with any kind of iron or steel. The deposited metal is non-machinable but flows on smoothly enough to obviate excessive grinding.

The other Stoody product mentioned, Borium, is made in irregular, pea-size shapes and in tubular form. It also is used extensively as a tipping material for fishtails, core bits and so forth. Besides being unmachinable it cannot even be ground by ordinary methods. Therefore in many cases slots are cut in the teeth of bits to provide recesses for the pieces of Borium. The pieces are brazed in position by fusion of hard-facing metal around them.

Rustless iron, a product of the Rustless Iron Corp. of America, is another material which attracted attention and which undoubtedly will find many uses in the design of machine parts subject to corrosion. It is a chrome-iron alloy. One of the brands contains 16 to 18 per cent chromium, 0.1 per cent carbon and less than 0.5 per cent silicon. This brand is said to be highly corrosion resistant without polishing. It can be hot rolled, pierced and forged, and shows negligible grain growth up to 1500 degrees Fahr.

Zinc base alloys having high tensile strengths were featured in a variety of die castings exhibited by the New Jersey Zinc Co., and aluminum alloys with tensile strengths up to 70,000 pounds per square inch were shown by the Aluminum

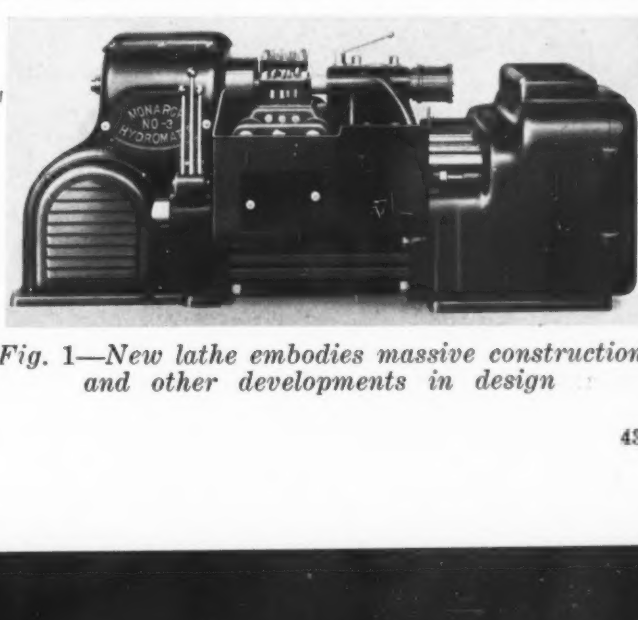


Fig. 1—New lathe embodies massive construction and other developments in design

Co. of America. These aluminum alloys contain 2 to 5 per cent copper and are used to a large extent in the design of all-metal airplanes and other products where combined lightness and strength is essential.

The Monarch hydraulic automatic lathe shown in Fig. 1 furnishes an instance of the development in sturdy construction. Its design renders it well adaptable to the use of the new tungsten carbide tools. On this machine the drive is taken direct from a motor mounted in the base, working through a multiple-disk clutch and thence through a worm gear and pick-off gears. All controls are hydraulic. A two-horsepower motor drives the two Oilgear pumps used for this purpose. The carriages clamp onto round steel bars which slide in bushings in the head and tail housings. Two round, hardened steel bars support the tool slides and are provided with adjustable taper bushings to compensate for wear, thus maintaining the necessary rigidity at this point. The tailstock spindle can be controlled manually, hydraulically or by air, and any desired headstock spindle speed up to 550 revolutions per minute is available. All shafts, including the main spindle, are equipped with tapered roller bearings.

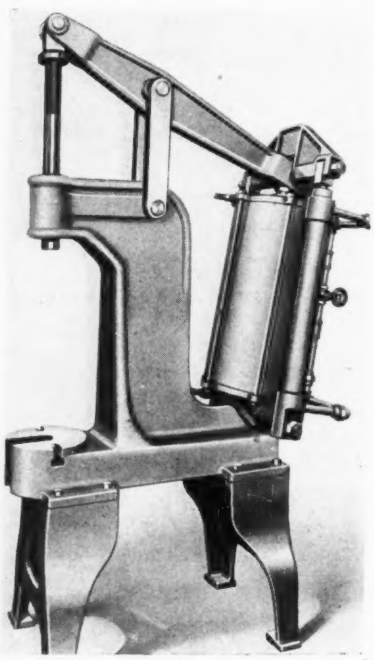


Fig. 2—Press combines hydraulic and pneumatic features

Among the lighter lathes designed for the use of the new cutting tools is the Carbo-Lathe built by the Porter-Cable Machine Co., Syracuse, N. Y. Rigidity is again a feature and is obtained to a large extent by the employment of only four main parts, or castings, in its construction. The headstock and bed form one casting in this machine. High speed steel is used for the lathe centers, and antifriction bearings are employed throughout.

A New Hydro-Pneumatic Tool

Employment on machines of various kinds of pneumatic and hydraulic operation and control is increasing rapidly. A new machine developed by the Hannifin Mfg. Co., Chicago, which embodies a combination of the two methods, was on display at the machine tool exposition held at Cleveland recently. The machine, shown in Fig. 2, is intended for broaching comparatively short holes.

The use of an air-operated press for broaching is claimed to be impractical due to the speed of the ram causing the broach to plunge into the hole and break. The designers of this machine therefore have provided for adjustable and uniform speed of travel by employing a system of hydraulic control. Two small hydraulic cylinders are mounted on opposite sides of the air operated cylinder. The piston rods of the hydraulic cylinders are connected to the piston of the air cylinder by means of a cast steel cross arm. Speed control is accomplished by regulated transfer of oil from the top to the bottom of the oil control cylinders. During the power stroke the oil is compelled to pass through a needle valve which can be set for any desired speed and on the return stroke the oil passes through a swing check thus permitting the ram to return to top position at full speed.

The hydraulic control results in uniform travel of the ram at any desired speed, and operation of the press is said to be faster than that of a full hydraulic broaching press.

Pneumatic Feed Employed

An interesting method of feeding work in an automatic lathe is employed by the Seneca Falls Machine Co., on its new "Lo-Swing" model U machine which also was on display at the machine tool exposition. The feeding device, which is operated pneumatically, loads and unloads pistons

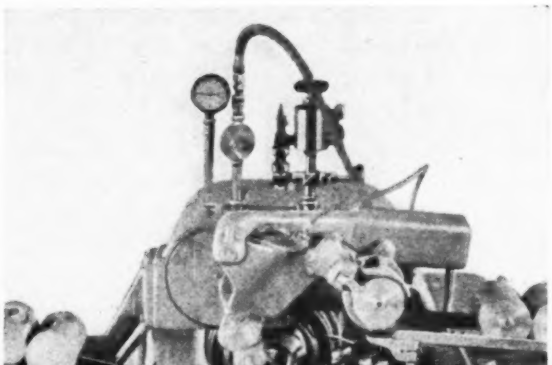


Fig. 3—Pneumatic feed loads and unloads pistons on automatic lathe

or other short cylindrical work. All operations of the machine are automatic.

Fig. 3 shows the feeder in operation, with the feed runway at the left and the finished work runway at right. In the illustration, one set of gripping fingers is shown placing a piston in position for turning and grooving operations while the other is delivering a finished piston to the runway. The loading and unloading grippers work simultaneously and swing clear during the turning process. To load the work the arm on which the fingers are located swings over to the left, one gripper clamps on the finished piston and the other picks up a new piston from the feed runway. The arm then swings to the right and operations are repeated.

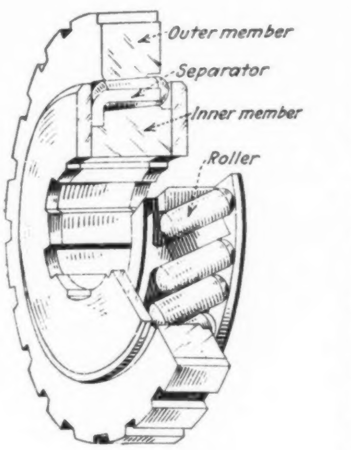


Fig. 4 — Unidirectional clutch

The tailstock center also is pneumatically operated and is controlled by adjustable cams operating pneumatic valves. Loading and unloading of the machine, from the finishing of one piston to the starting cut on the next, takes only about $3\frac{1}{2}$ seconds.

Rollers Used in Clutch Mechanism

Somewhat unique is the ratchet device or unidirectional clutch which is being marketed, according to "*The Industrial Chemist*," by the Humfrey-Sandberg Sales Co., Smith Square, London, England. The clutch received its first application on an ebonite feeding device in a chemical plant.

Fig. 4 shows the cluch in a cutaway view. Interposed between the inner and outer annular races is a set of cylindrical rollers similar to those used in ordinary roller bearings. The axes of the rollers are inclined at an angle to the axes of the annular races and the rollers maintain line contact with the races on account of the conoidal form of the contacting surfaces of the inner and outer races.

Relative motion between the races is possible in one direction as the rollers will rotate in the same manner as in a roller bearing. If the race is turned in the opposite direction however, the rollers jam instantly and the whole unit is forced to rotate together. It is claimed that the jamming is instantaneous and that no backlash occurs. The new device is silent in operation.

If used for speed reduction in a ratchet mechanism an oscillating motion is imparted to the drive member of the clutch, the driven member being connected to the part to be operated. To obtain the oscillating motion an adjustable crank may be employed thus permitting infinite variation, within the limits of the crank, of the motion to be transmitted.

A new device for taking up the slack of belts is offered by H. M. Perry, 638 N. Main St., Los Angeles. This device is particularly adaptable to vertical drives and depends for its success upon the adjustable tension of a cantilever spring pressing against the ends of a pair of swinging arms between which a roller bearing idler is mounted. The spring is fastened to a bar on which the arms swing, and the entire mechanism is located, in relation to the belt drive, in such a position that as the spring tension decreases the belt wrap around the smaller pulley increases.

Employing Practical Suggestions For Laying Out Cams

(*Concluded from Page* 39)

bear in mind. Otherwise a false movement will be developed.

The designer could of course make a drawing similar to Fig. 9 for the guidance of the toolmaker. However, time can be saved if the designer will lay out the form on the brass disk himself. It is of course understood that machinist's dividers and a stiff scriber be used for this work as draftsmen's tools are too fragile.

Suppose it is necessary to lay out the motion shown in Fig. 2 as a drum or barrel cam. In this case the brass leader must be long enough to wrap around a drum to be used on the cam cutting machine. The size of this drum should be larger in diameter than the cams to be cut. The layout shown in Fig. 2 is shown again in Fig. 10 as it would appear in making a master for a drum cam. As all the curves are modified uniform rises they will not cut back. The overlaps, *A*, are cut away after the motion is laid out as lines *B* represent like portions of the cam movement.

Oftentimes the designer will be confronted with the problem of laying out several cams to operate on one shaft, or to design cams with two or more grooves. In this case he should draw a cam chart similar to the one shown in Fig. 2, but including all the movements. It is then a simple matter to compare them readily to determine just when one motion starts in relation to the movements of other cams.

Men of Machines

Personal Glimpses of Engineers, Designers, and Others Whose Activities Influence Design

JESSE GURNEY VINCENT, vice president of the Packard Motor Car Co., Detroit,, has held a prominent position in the field of engineering and design for many years. He was closely identified during the war with the design of the famous Liberty motor and with the organization and control of various airplane engine design units. Born in Charleston, Ark., Mr. Vincent commenced his engineering training at an early age, serving some time as a machinist and toolmaker. Entering the design department of Burroughs Adding Machine Co. in 1903 he rose to the position of superintendent of inventions. Later he became successively chief engineer of the Hudson Motor Car Co. and then of the Packard Motor Car Co. About a year after he was elected vice president of this concern, in charge of all engineering activities, this being the position he now holds.

* * *

Recently appointed president of the American Society for Testing Materials, Tillman Danis Lynch has been active in metallurgical research work since 1896. Five years earlier he was graduated from West Virginia university and held various engineering positions until he became affiliated with the Westinghouse Electric & Mfg. Co. in 1899. He still is connected with the same company. Mr. Lynch has served in many offices of technical associations, being vice president of the American Society for Steel Treating in 1919-20 and president in 1922. He was a director in 1925-26 of the society of which he is now president. He also is chairman of the metallurgical advisory board of Carnegie Institute of Technology, Pittsburgh, and the United States bureau of mines, Pittsburgh division.

* * *

Ralph E. Flanders, recently nominated for vice president of the American Society of Mechanical Engineers, was born at Barnet, Vt., in 1880, and was educated at Central Falls, R. I. He served as an apprentice machinist with the Brown & Sharpe Mfg. Co., Providence, R. I., and then entered its drafting room. Making a change, he designed machinery and developed special tools at the International Paper Box Machine Co., Nashua, N. H., for some years, and later became connected with the Fellows Gear Shaper Co. on engineering work. In 1912 he went with the Jones & Lamson Machine Co., and since 1914 has held the position of general manager of this concern. Mr. Flanders is a recognized authority on machine tool design and shop management, and is author of a book *Gear Cutting Machinery*. He has served on many committees of the American Society of Mechanical Engineers and has been a manager of this society from 1926 to 1929.

* * *

Col. L. S. Horner recently was appointed chairman of the newly created advisory committee on the census of manufactures. For some years he has been closely connected with the machine tool industry as president of the Niles-Bement-Pond Co., New York. The successful reorganization of this company was due largely to his efforts and has stamped him as a leader in this field. As vice president of the National Electric Condenser Co., New Haven, Conn., a unit of the Acme Wire Co. of which he was president from 1908 to 1926, Colonel Horner participated in important work on the development of power factors by static condensers. He was graduated from Lehigh university in 1898 and his first engineering work was with the construction department of the American Telephone & Telegraph Co., New York. He later became connected with the Crocker-Wheeler Electric Mfg. Co., Ampere, N. J., with which concern he remained until he joined the Acme Wire Co.

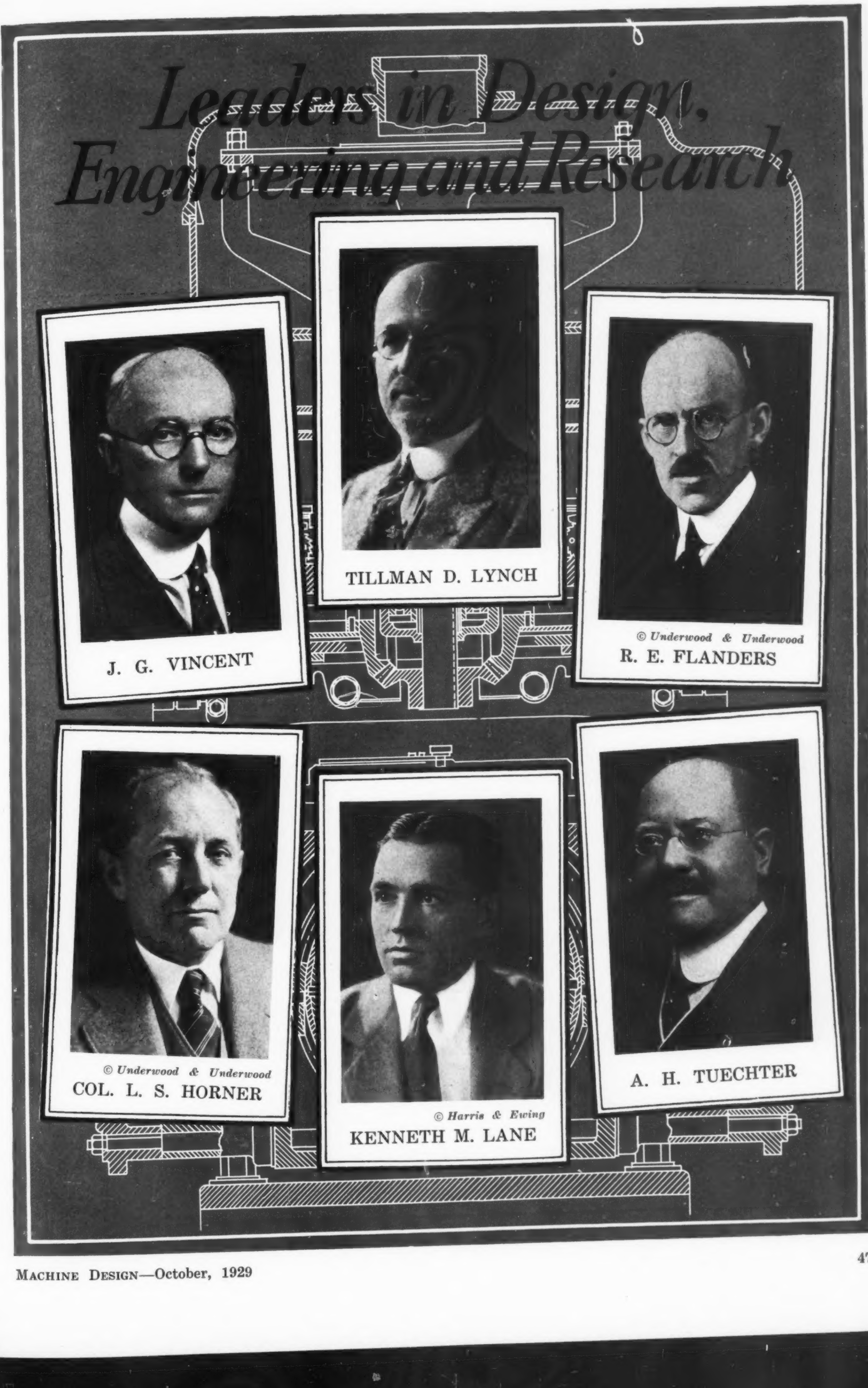
* * *

A portrait of Kenneth M. Lane, who was mentioned in *Machine Design* for September as having been appointed chief engineer of the aeronautics branch of the department of commerce, is reproduced on the opposite page.

* * *

August H. Tuechter has just completed his forty-fourth year in the machine tool industry—an industry which has contributed largely during that time to the progress of the civilized world. Mr. Tuechter has been president of the Cincinnati

(*Concluded on Page* 48)


Leaders in Design, Engineering and Research
TILLMAN D. LYNCH
J. G. VINCENT
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R. E. FLANDERS
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COL. L. S. HORNER
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KENNETH M. LANE
A. H. TUECHTER

H. Cole Estep

1886 — 1929

H. Cole Estep, widely known in the field of business paper publishing and closely identified with American and European engineering and industrial activities, died suddenly in Cleveland, Sept. 30, of heart failure.

Mr. Estep was born at Stampede Tunnel, Wash., Sept. 27, 1886. After graduating from the school

H. COLE ESTEP

of mechanical engineering, University of Minnesota, in 1908, he became affiliated with the editorial staff of the Penton Publishing Co. as assistant to Robert Thurston Kent, then engineering editor of *Iron Trade Review*. In 1914 he became associate editor of *The Foundry* and engineering editor of *Iron Trade Review*, and later was editor of *Marine Review* and editorial director of the Penton Publishing Co. In 1920 he went to London to establish the Penton Publishing Co. Ltd. and after five years' residence abroad he returned to Cleveland as first vice president of the American company.

Mr. Estep has been closely associated with organizations in the iron, steel and foundry industries. As chairman of the international relations committee of the American Foundrymen's association he was largely responsible for bringing European and American foundrymen together on a basis of practical co-operation. He was a director of the A. F. A. and secretary of the Foundry Equipment Manufacturers' association.

As president of the Johnson Publishing Co., Mr. Estep in the past few months had been deeply interested in *Machine Design*. He was a member of the American Society of Mechanical Engineers, British Iron and Steel institute, Institute of British Foundrymen, Association Technique de Fonderie de France, Engineers' Club of London, Cleveland club, and Chagrin Valley Country club, Cleveland.

Men of Machines

(*Concluded from Page* 46)

Bickford Tool Co., Cincinnati, since 1909, when a consolidation was effected between the Cincinnati Machine Tool Co. and the Bickford Drill & Tool Co. which resulted in the formation of his present corporation. Prominent among his endeavors in development of the machine tool industry has been his association with the National Metal Trades association of which he was among the founders; also as president, from 1920 to 1923, of the National Machine Tool Builders association.

* * *

Herbert L. Seward, professor of mechanical engineering in the Sheffield Scientific School, Yale University, has been appointed assistant to Captain A. McAllister, president of the American bureau of shipping.

* * *

E. F. Elderton has been appointed chief engineer of the Boeing Aircraft Co. of Canada, Ltd. Formerly he was connected with Canadian Vickers, Ltd., Montreal.

* * *

E. R. Tyrell, formerly with the Sharon Steel Hoop Co., at Youngstown, O., has been appointed chief engineer of the McKay Machine Co., of the same city.

* * *

Harry Bubb has been appointed chief metallurgist, and Daniel Kellcher, chief engineer, of Thompson Research, Inc., Cleveland.

* * *

Joseph H. Dillon has been appointed chief engineer of the Wisconsin steelworks of the International Harvester Co., Inc., South Chicago, Ill., succeeding William Forsstrom, resigned.

How Designers Benefit From Sales Contacts

(*Concluded from Page* 42)

ployed and in others where unskilled labor only is used. Naturally operators in both these classes have little or no knowledge of machine construction with the result that machines often suffer from severe abuse or neglect at their hands.

Other Operating Conditions Vary

Apart from manual operation there are the conditions characteristic of the industry as, for example, those met with in factories manufacturing products in which abrasives figure largely. The writer some years ago visited a plant engaged in the manufacture of a special roofing material. The amount of grit in the air in that factory was sufficient to ruin any machine.

Competition is one of the factors about which a designer does not concern himself greatly except possibly in a general sense. Yet the district sales manager in most lines meets it every day—often in connection with each sale made. The result is that if he applies himself to the task he can gain accurate knowledge covering the reasons for certain types of machines having ready sales, and the reasons why others fall behind. It is the sound and practical transference of this accumulated knowledge which often has been the means of enabling engineering departments to visualize requirements and create machines eminently suited to the market.

The same thing applies to types and temperaments of customers. A maker of a diversified line once considered that manufactured parts which were incorporated in one kind of machine were satisfactory for another. He found later, however that where a customer's training has been largely confined to a particular machinery field his ideas are to a large extent governed by the practices of that field.

Manufacturers Canvass Industries

Regional or district likes and dislikes are diminishing with the increase in transfer of thoughts and ideas. Rather is it the case that one trade has been canvassed intensely by the manufacturer of a certain type of, say, antifriction bearings. Considerable advantage can be taken of this by designers in choosing for their machines the type of bearing which not only meets requirements satisfactorily but which also has been designed with field applications primarily in mind.

Education of customers to the acceptance of revolutionary ideas in design enters into the picture. Here again, from its contacts, the sales staff is in an excellent position to act in an advisory capacity to the design department.

Who is forced to accept the responsibility when sales are slow? Perhaps it is natural for the salesman who believes he is doing everything possible to put the product across, to blame the engineering department for its design. But there are many other factors which operate to influence the salability of a machine and in justice to the designers most sales executives take these factors into consideration before trying to lay the burden at the feet of the chief engineer. The machine being on the market, the salesman's first and foremost duty is to sell it.

Suggestions for New Machines

While many of the ideas, which prompt new designs, originate in the engineering department, live and observant sales forces in many leading companies are responsible for bringing in suggestions which are the foundation for satisfactory and salable machines. Intensive consideration and research is usually first undertaken by the sales executives to make absolutely sure the market for the machine is neither limited nor overrun by existing competitive models. In these cases, following or even during the survey, if the market offers prospects, cooperation with the design department commences. Designers are sent into the field to study details and gather essential facts. In this work some assistance is rendered them by the salesmen who already have contact with the plants visited. It is up to the designers to carry back to the engineering department all the data relating in any way to the design of the new machine.

Field Reports are Analyzed

The chief engineer receives reports varying with district and other conditions, from the different design men sent out. These reports are segregated and a basis for design then is formulated. In the final decisions the sales executives are consulted. This coordination has, besides others, a psychological advantage in that it depends in a large measure on the enthusiasm of the whole sales department as to whether the machine will reach a high sales mark. Particularly so if the machine does not embody some brilliant design feature which goes a long way toward selling it with the aid of normal advertising. Knowledge on the part of the sales executive and his staff that they have assisted materially in the design of the new machine tends to eliminate "come backs" and furnishes an additional incentive to put forward maximum selling efforts.

The Editor's Mail Basket

IT IS said the proof of the pudding is in the eating! How much more so does the proof of a new journal lie in the reception it receives from the profession it serves? Little or no response to an initial issue could mean only that the journal did not fill a want, was considered limited in the breadth of its editorial content or was unsuitable from other aspects. That Machine Design does not fall into any one of these categories but rather that it is being welcomed heartily and in fact accorded a rousing reception is indicated conclusively by the hundreds of telegrams and letters of congratulation received since the first issue was distributed. Most of these naturally are from chief engineers, chief draftsmen, designers and others closely identified with design; others were received from sales and production executives, and others from kindred leaders in the engineering field whose activities bring them into contact with the design of machinery.

Indicative of the feeling among chief engineers and chief draftsmen are the three following abstracts. These typical examples were taken from letters received from members of three of the most important machinery manufacturing concerns in the country:

"As to the first issue, I sincerely like it—every bit of it. Frankly, when I first heard of your proposal for a new magazine, I wondered just how you could dovetail in with all the others in the general field, but I am now convinced that you have found a distinct field not previously covered."

"You are to be congratulated on your first issue. Was well gotten up and should go over big if subsequent issues hold up to the first standard. All comments I have heard are very complimentary."

"Many thanks for the copy of the first issue of *Machine Design* which I looked over with considerable interest, although I have not yet read it thoroughly. You are to be congratulated on the results of your efforts and have my best wishes for the continued success of your undertaking."

Research engineers and development engineers find in Machine Design a technical journal eminently suited to their field, as witness the following abstracts of letters received from representatives of these groups:

"We have enjoyed looking over the September issue of *Machine Design* and have decided to enter our subscription to this interesting and informative periodical. We were particularly glad to find in the first number a description of the photo-electric cell that is used in sorting cigars, as we had been planning to learn about this machine. The article about it has saved us quite a bit of time."

"With the first issue of *Machine Design*, you began a very difficult and most important work for industry, the need of which has been felt for years."

The following is quoted from the letter of a production executive:

"The editorials I read carefully and approve of heartily. The writing is very lucid, and the layout of the pages appeals to me. I think this first issue is very creditable, and hope that the magazine will continue as it has started."

Here are the opening remarks of a typical letter received from a general manager of a machinery manufacturing company:

"Volume I, No. 1 of *Machine Design* has come to hand, and I venture to compliment you on the issue. I was interested particularly in your remarks regarding spring design, etc., in the first article."

The following indicates the study which is being given to the subject matter treated in the first issue.

"I am very much interested in the one copy we have the initial issue of the magazine *Machine Design* of September, 1929, and I should like very much indeed to have a copy for myself."

Numbered among the most important elements in the design of machinery are our universities. The following is from a machine design professor who also is active in the industrial field.

"I want to offer you my sincere congratulations on the very excellent showing you have made. The appearance from the neat, tasteful cover to the last page is very pleasing, and all the text matter seems thoroughly worth while. I let the magazine circulate among some of the designers and engineers of this firm, and I was wishing that you had the opportunity to hear all the complimentary comments that were made."

Typical abstracts from the letters received from the engineering field in general, are:

"You are to be congratulated upon the splendid periodical which you have produced, and I hope you will find there is a real need for it."

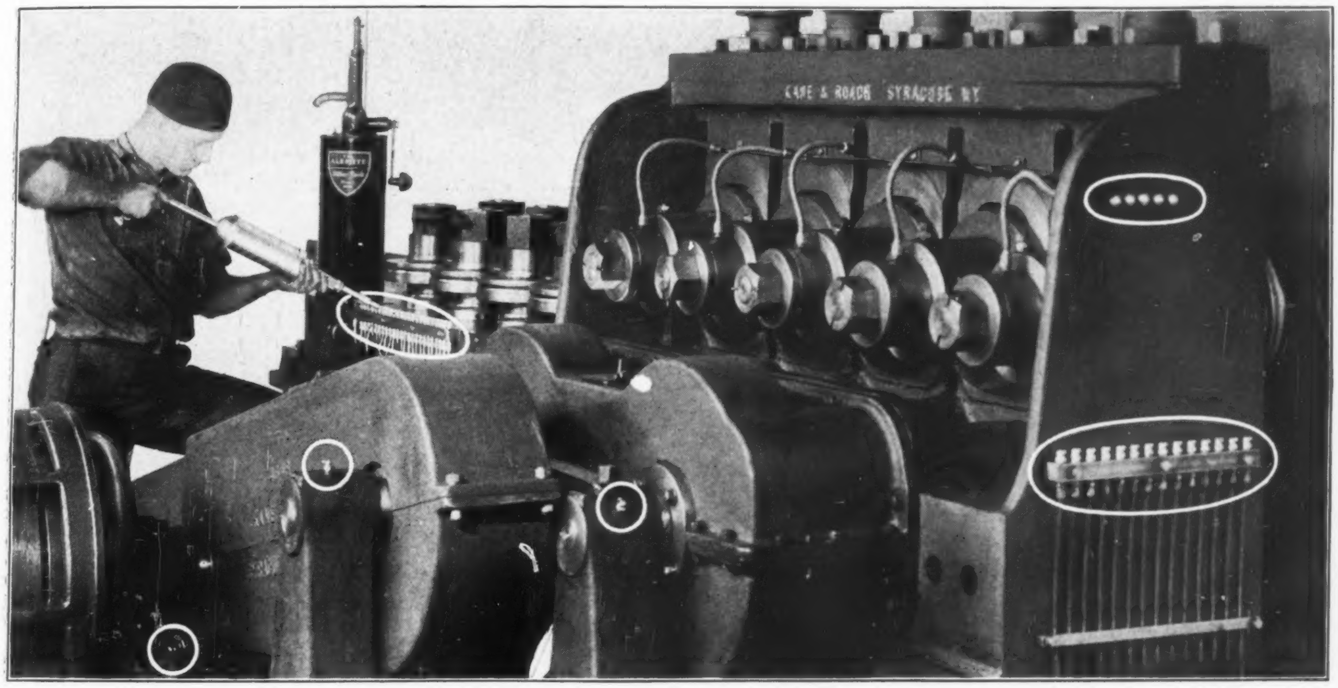
"We have just received the first copy of your new paper. It surely contains some very useful and interesting information for the machinery manufacturer."

"I need go no further than a casual reviewal of the initial issue of *Machine Design* before expressing great joy in your accomplishment."

"I have just received the first issue of your publication *Machine Design* and want to congratulate you on the makeup and contents of the same."

Modern Day Machinery Must Have Modern Day Lubrication!

"Ordinary, haphazard oiling no longer sufficient in today's high speed production", say leading users of machinery



Straightening Roll manufactured by Kane & Roach, Syracuse, N. Y., showing installations of fittings for Alemite high pressure lubrication

TREMENDOUS strides have been made in design and manufacturing of modern machinery. Yet until recently one important factor was overlooked in this development — *adequate lubrication.* Some few manufacturers still depend upon the hit or miss protection of an old-fashioned oil can—employing on modern day machines the lubrication method of a century or more ago!

The wear and tear on machinery caused by inefficient lubrication is no longer necessary.

American industry generally recognizes today the tremendous advantages to be secured by equipping the machines they make with Alemite High Pressure Lubrication. They know that proper lubrication, such as Alemite offers, means longer life, greater efficiency and freedom from repairs even under the most grueling service.

And, equally important, they know that industry at large now demands machinery with lubrication as modern as the design of the machine itself. Alemite-equipped machinery finds a far readier market in these days of high speed production.

More than 600 of the country's leading machinery manufacturers have already adopted this modern-day method of lubrication. And this roster is rapidly growing larger.

Alemite, since its inception, has kept pace with all engineering advancements in machine design. Today Alemite offers a variety of fittings that definitely obsoletes every oil and grease cup in machinery. Button-head fittings — push-type fittings — pin-type fittings—and now with Alemite's purchase of the Dot fitting and its continuation under the name of Alemite-Dot —every lubrication point on modern machinery becomes easily accessible.

There can be no wasted lubricant with this system, and bearings are cleaned of all grit and dirt when they are lubricated.

No more oil soaked floors and machinery. No more damaged materials, and above all, machinery repairs, which cut into production, are practically eliminated with this positive lubricating method. You'll even be able to notice an appreciable saving in power.

Write today for complete details of the savings which are now made possible by Alemite.

Alemite Corporation (Division of Stewart-Warner), 2644 North Crawford Avenue, Chicago, Ill. Canadian address: The Alemite Products Company of Canada, Ltd., Belleville, Ontario, Canada.

ALEMITE

High Pressure Lubrication for Modern Industry

ALEMITE CORPORATION
(Division of Stewart-Warner)
2644 N. Crawford Ave., Chicago, Ill.

Please send me complete information on Alemite.

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Address..........

City.......... *State*..........

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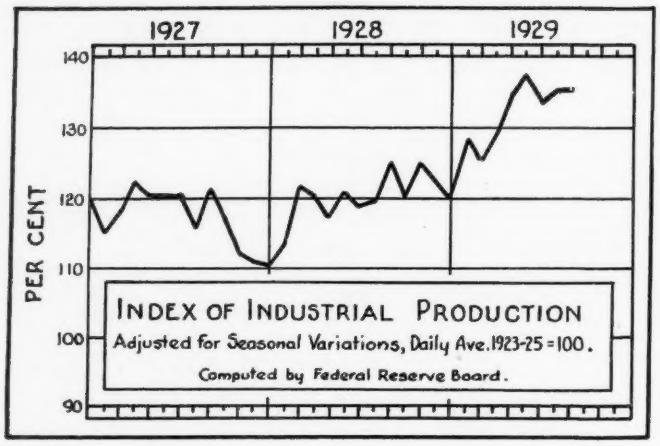
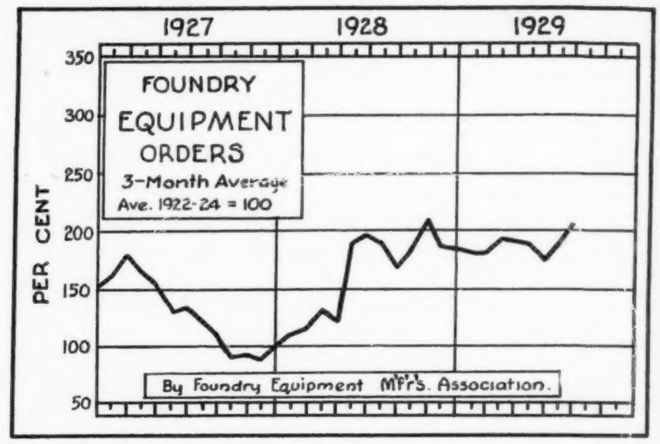


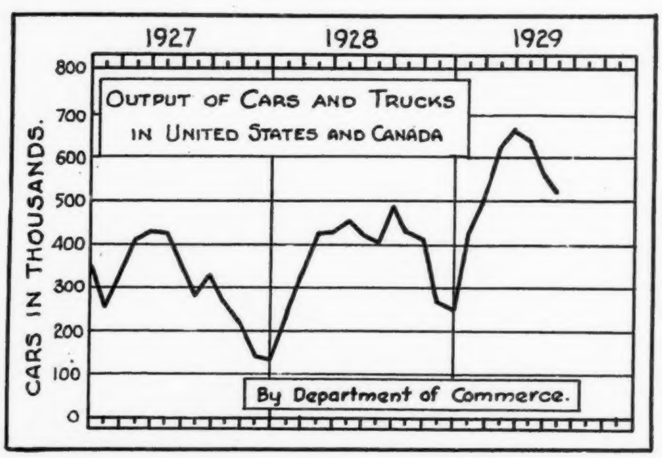


How Is Business?

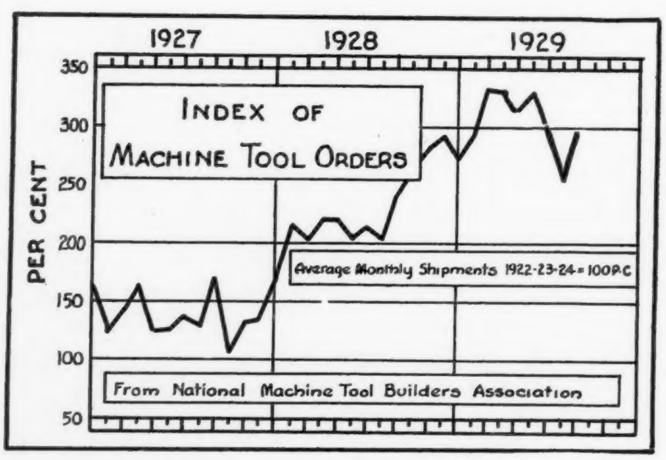
Recent industrial records indicate a continuance of activity at a good level, although there has been a measure of slackening in some lines from the extraordinary pace of preceding months. For trade in general, reports of freight car movements and wholesale trade reveal the usual autumn upward trend. In such industries as iron and steel and automobiles there has been some slackening, largely due to seasonal causes.

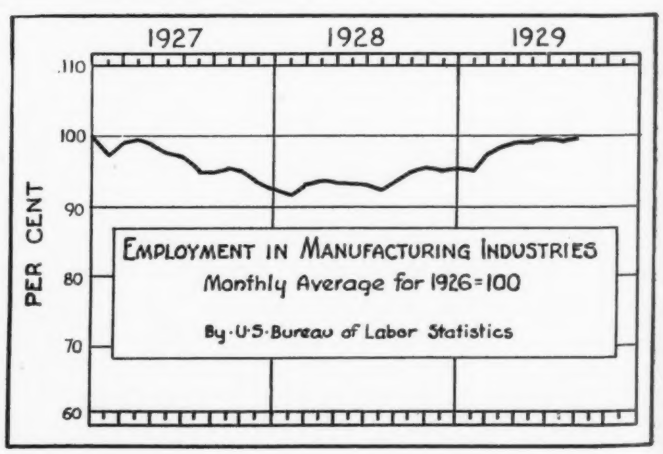
During the past year business has moved at a swift pace, with the result that employment and purchasing power in the country are high. Agricultural conditions also are generally favorable and the consumption of goods this autumn is expected to reach exceptional proportions.

Trends in the general manufacturing field are indicated by the accompanying charts. In most cases the level of activity remains higher than at this time one year ago. In the automobile industry curtailment is now being put into effect, but this is being partly offset by the increased purchases on the part of the railroads. During September the production of automobiles is estimated at 417,000 cars and trucks. This was nearly 40 per cent below the peak for the year in April and it was 20,000 cars less than the total for September, 1928. Following its summer letdown, business in the machine tool industry is again quickening and the volume of trade in this line remains on a plane far above that of one year ago. Orders for foundry equipment also have been encouraging during recent weeks.



In the main, industry is holding a good rate of activity. Fundamental conditions continue sound and there is nothing in the prospect to indicate any major downward trend.





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Review of Noteworthy Patents

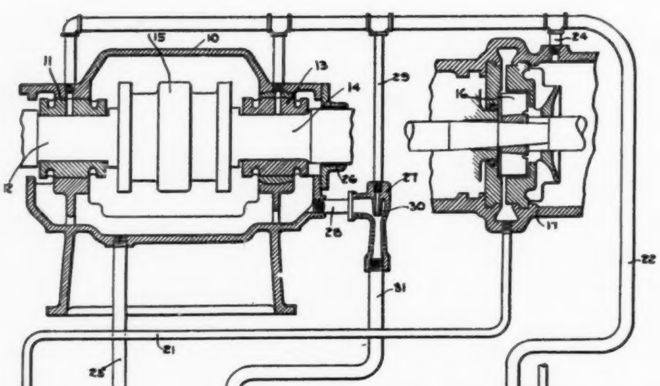
A Monthly Digest of Recently Patented Machines, Parts and Materials Pertaining To Design

AMONG the patents granted by the United States patent office during the month of September and which are significant from the standpoint of design is No. 1,728,268 for a bearing housing. The inventor is Warren B. Flanders, Philadelphia, who has assigned the patent to the Westinghouse Ele. :ric & Mfg. Co., East Pittsburgh, Pa.

The invention relates to a housing for a bearing which is continually supplied with liquid lubricant. Its object is to withdraw the lubricant vapor from the housing and to condense it efficiently. It is desirable to retain this vapor, particularly in the case of a turbo-generator, because such vapors have an injurious effect on insulation.

In Mr. Flanders' invention, an ejector is provided for withdrawing the vapor from the housing, the ejector being motivated by liquid lubricant supplied from some part of the lubricating system. The vapor thus is brought into intimate contact with liquid lubricant and is condensed.

The apparatus covered by the patent is shown in the accompanying illustration. Its operation is as follows:



Device condenses lubicant vapor

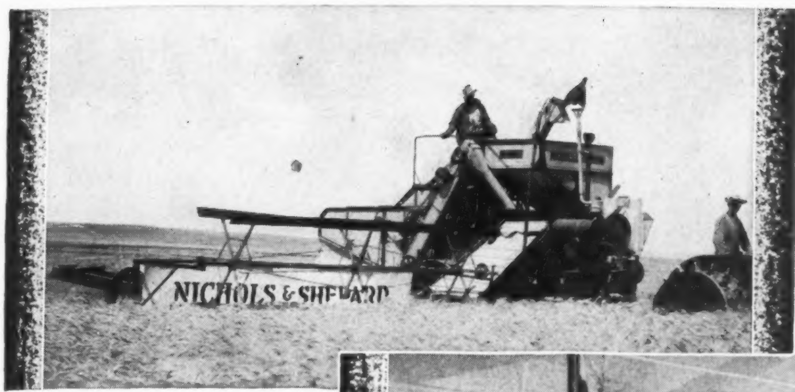
The pump 17 develops a fluid pressure, for example, 50 pounds per square inch, which is communicated through the conduit 21 to the ejector 19. A quantity of lubricant from the reservoir 18 is entrained in the ejector 19 and discharged to the conduit 22 at a lower pressure, for example 5 pounds per square inch. This lubricant passes through the cooler 23, in which its temperature is substantially reduced and from which it is supplied to the inlet of the pump 17, to the bearings, and to the ejector 27.

The lubricant supplied to the bearings 11 and 13 is heated by the rapid rotation of the shafts mounted therein, and a portion thereof is vaporized, being transformed into the true gaseous state by the heat of vaporization. A portion of the lubricant is also atomized or broken up into finely divided particles which are suspended in the air and gaseous lubricant within the bearing housing. The lubricant vapors thus generated fill the housing 10 and slowly escape by the packing 26 unless withdrawn.

The ejector 27, motivated by the cooled lubricant supplied through the conduits 22 and 29, creates a partial vacuum in the entraining chamber thereof, causing the lubricant vapor and other gaseous media in the housing 10 to flow through the conduit 28 to the entraining chamber, in which it is entrained in the liquid lubricant flowing through the ejector 27.

As the lubricant vapors are entrained in the liquid lubricant, the suspended particles are brought into intimate contact with the body of liquid and unite therewith. The lubricant in gaseous state delivers its heat of vaporization to the body of liquid and is condensed, also uniting therewith. The liquefied lubricant flows to the reservoir 18 through the conduit 31 and is again used in the lubrication system.

A slight vacuum is maintained in the housing by the ejector 27. A slight flow of air into the housing by the packing 26 is therefore obtained. The possibility of the escape of lubricant vapors by the packing is thus eliminated. The air mixed with the lubricant vapors is withdrawn with them



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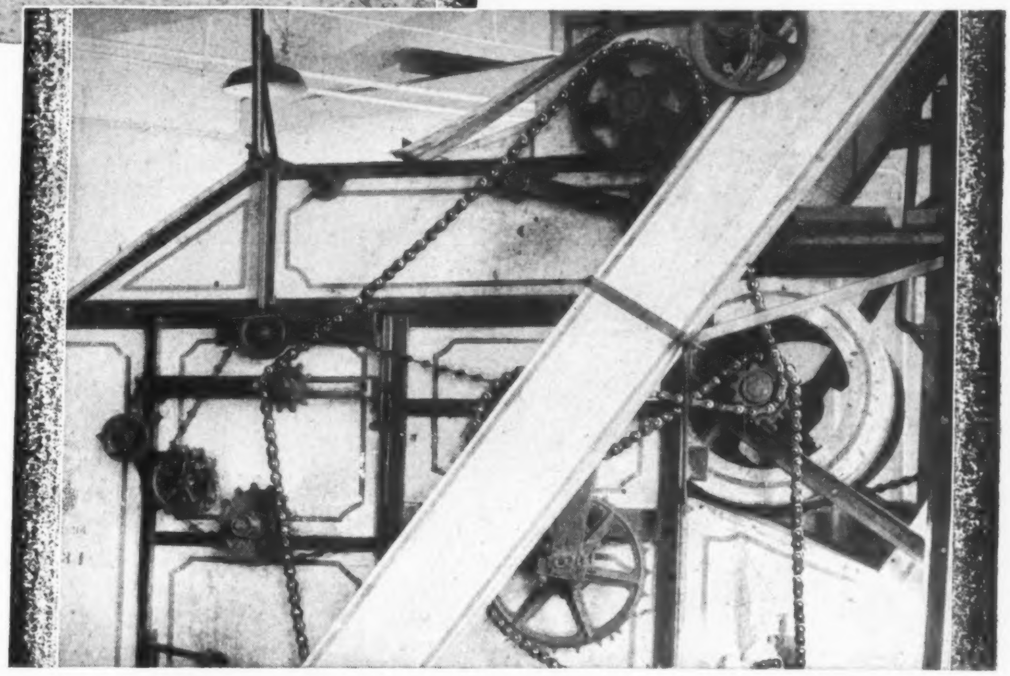

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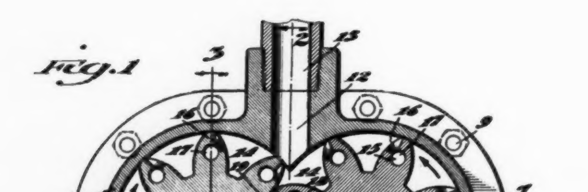
(8808)

and is separated from the lubricant in the reservoir 18, from which it returns to the atmosphere by way of a suitable vent 32.

The inventor declares that this "simple and compact apparatus may be readily applied to existing lubrication systems, as only an ejector and connecting conduits are required to be added. As there are no moving parts, no attention on the part of the operator is required, when the turbo-generator is in operation. The lubricant vapors are not only removed but are also returned to the lubricant reservoir in liquid state for reuse."

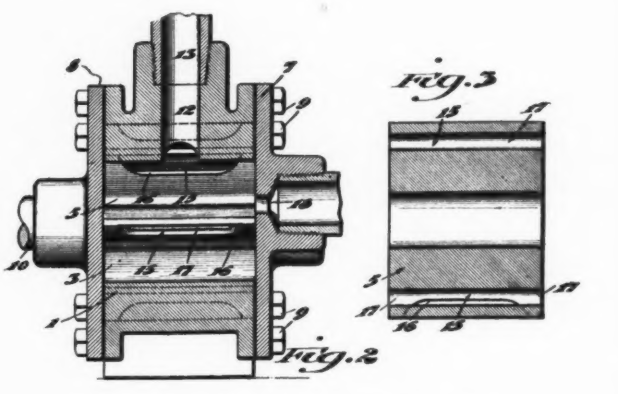
Patent No. 1,728,528 has been granted Clyde G. Butler, Cincinnati, for a fluid-pressure rotor which can be employed for translating rotary power into fluid pressure or conversely fluid pressure into rotary power. The patent has been assigned to the Cincinnati Ball Crank Co., Cincinnati.

As shown in Figs. 1, 2 and 3, the invention contemplates the use of a pair of intermeshing gears formed with fluid passageways extending from a tooth portion of one or both gears to an end or face portion thereof. These conduits extending through the gears are arranged to rotatively co-act with ports in the enclosing casing to transmit fluid to or from said ports. The gear rotation intermediate said casing ports provides a series of successively presented compartments between gear teeth in the zone of their intermesh, each compartment traversed by the meshing tooth and thereby constituting a transient fluid pressure chamber in communication through the gearing



Sectional view of fluid-pressure rotor

passageways, with one or the other of said casing ports according to the direction of gear rotation. It will thus be seen that a rotor is provided which operates as a pump when said gears are driven and said fluid pressure chambers are in communication with the end openings of the passageways for the outlet of the fluid, or as a motor when fluid under pressure is admitted through the port communicating with the face or end apertures of said gear passageways in which case the fluid pressure chamber between gear teeth communicates with the passageways having outlet through



Cross sections of rotor and gear

a circumferential portion of the gear tooth and outwardly through the adjacent port.

Review of Noteworthy Patents

Other patents pertaining to design are briefly described as follows:

ELECTRIC-ARC WELDING—1,728,863, for a method of "electric-arc welding which comprises maintaining an arc between the work, constituting one electrode, and a pencil, constituting the other electrode, while applying a vaporizable liquid to the electrode in such quantity that part thereof is carried to the arcing terminal of the pencil and there vaporized to form a protective atmosphere about the arc and molten portions of the work." Assigned to General Electric Co., Schenectady, N. Y.

SAFETY DEVICE—1,729,079, for "a conveyor comprising, a belt, driving mechanism for the belt, running gear attached to the belt, tracks for supporting said running gear, a movable member positioned to be normally disengaged from said running gear but to be engaged and moved thereby upon the belt becoming slack, and means operated as a result of said movement of said member for causing the stopping of the driving mechanism." Assigned to Otis Elevator Co., Jersey City, N. J.

MOTOR—17,428, for "a motor having a plurality of cylinders arranged in parallel rows, each of said cylinders having a piston and a piston rod, a plurality of engine shafts arranged in parallel relation and connected together at one end, oblong cam members secured to said engine shafts and arranged so as to extend one at an angle to the other and disposed so as to bear constantly upon the free ends of said piston rods, a beam member pivotally supported between the said cylinders of the motor and having its opposite ends pivotally connected to the end portions of said piston rods. Assigned to Marchetti-Motor Patents, Inc., San Francisco.

WIRE MACHINE—1,726,528, for making and inserting wire devices. Assigned to Saranac Automatic Machine Corp., Benton Harbor, Mich.

CONVEYOR—1,726,555, for a "conveyor comprising an endless carrier-belt and a succession of members underlying substantially all of and supporting the load-carrying

reach of the belt, each of said members being adapted to travel with the belt in an orbital movement extending longitudinally of the belt, and the succession of members defining an undulating path for the belt." Assigned to B. F. Goodrich Co., New York.

BRAKE—1,726,712, for a "braking mechanism, a rotatable drum, a dust cover therefor, braking means engageable with said drum, a pair of pivoted levers supported by said dust cover within said drum engageable with the ends of said braking means substantially in the circular path thereof for moving said braking means to engage said drum, one of said levers having a shiftable pivot point, a link pivotally connecting said levers, and means for actuating said levers." Assigned to The Studebaker Corp., Detroit.

TIRE MACHINE—1,726,755, for making tire-forming material. Assigned to the Cord Tire Machine Co., Cleveland.

ENGINE FUEL PUMP—1,726,937. In an airless fuel injection device for internal combustion engines, a combined pump and accumulator comprising a plunger barrel, a plunger, a suction valve, and a delivery valve, in combination with engine-operated reciprocating means to effect through positive means the suction stroke of the plunger, and to effect through resilient means the delivery stroke of the plunger, suction valve lifting means operated by said reciprocating means, control means to vary the point of plunger travel at which said lifting means allows the suction valve to close, and engine-operated means to open said delivery valve." Assigned to Busch-Sulzer Bros.,—Diesel Engine Co., St. Louis.

BALANCING DEVICE—1,727,122. "In a rolling mill, a roll, a housing, an adjusting means, a drive member for operating said means, a pair of lifting devices disposed one at each side of said drive member and mounted on said housing, a yoke supported between said devices, means depending from said yoke, and means carried by said depending means for supporting said roll." Assigned to the Bethlehem Steel Co., Bethlehem, Pa.

SHEET-STACKING MACHINE—1,727,209, for "a sheet stacking machine including retractable wheels for catching and conveying a sheet at the edges thereof and means for retracting the catching and conveying wheels to drop a sheet caught thereby, and the sheet catching wheels including means for maintaining a caught sheet at a predetermined elevation until the caught sheet is dropped by retraction of the catching wheels." Assigned to the Berger Mfg. Co., Canton, O.

PRINTING-PUNCH MECHANISM—1,727,471, for "a record card preparing machine, comprising in combination a punching mechanism, a card analyzing unit for analyzing the punched cards, and means controlled by said unit for printing characters on said card corresponding to the data represented by the card perforations." Assigned to Remington Rand Inc., New York.

ROLLER BEARING—1,727,576, for "a roller bearing comprising a bearing cone having a thrust rib at its large end, a bearing cup, and a series of headless rollers between said cone and said cup, the end of each roller contracting endwise against said thrust rib at only two points spaced apart and located inwardly from the edge of the roller, and one of the contracting surfaces being convexly curved in longitudinal section through each point of contact. Assigned to The Timken Roller Bearing Co., Canton, O.

RADIAL DRILL—1,727,606, for a constant-drive radial drill. Assigned to The Cincinnati Bickford Tool Co., Cincinnati.

FEEDER—1,727,634, for a "feeding mechanism including a drum mounted for rotation, having a peripheral groove, a rotatable annularly grooved roll cooperating with the grooved drum for gripping and guiding material directed therebetween, material pulling mechanism, and means for operating the same to withdraw material from the drum at a lesser speed than it is supplied thereto." Assigned to The National Machinery Co., Tiffin, O.

Calendar of Meetings

Oct. 14-18—American Gas association. Eleventh annual convention at Atlantic City, N. J. Alexander Forward, 420 Lexington avenue, New York, is managing director.

Oct. 16—Gray Iron institute. Annual meeting at Hotel Cleveland, Cleveland. Arthur J. Tuscany, Terminal Tower building, Cleveland, is manager.

Oct. 21-24—American Hardware Manufacturers association. Annual meeting at the Marlborough-Blenheim hotel, Atlantic City, N. J. Charles F. Rockwell, 342 Madison avenue, New York, is secretary-treasurer.

Oct. 21-24—National Hardware Association of the United States. Thirty-fifth annual convention at the Marlborough-Blenheim hotel, Atlantic City, N. J. George A. Fernley, 505 Arch street, Philadelphia, is secretary-treasurer.

Oct. 23-25—Society of Industrial Engineers. Sixteenth national convention at Hotel Statler, Cleveland. George C. Dent, 205 West Wacker drive, Chicago, is secretary.

Oct. 24-26—American Gear Manufacturers association. Semiannual meeting at Benjamin Franklin hotel, Philadelphia. T. W. Owen, 3608 Euclid avenue, Cleveland, is secretary.

Oct. 25—American Iron and Steel institute. General fall meeting at Hotel Commodore, New York. E. A. S. Clarke, 75 West street, New York, is secretary.

Oct. 29-Nov. 1—American Management association. Autumn meeting at Hotel Statler, Detroit. W. J. Donald, 20 Vesey street, New York, is managing director.

Nov. 4-7—National Association of Practical Refrigerating Engineers. Twentieth annual convention at William Penn hotel, Pittsburgh. E. H. Fox, 5707 West Lake street, Chicago, is secretary.

Nov. 13-16—American Institute of Steel Construction. Annual convention at Edgewater Gulf hotel, Biloxi, Miss. Charles F. Abbott, 200 Madison avenue, New York, is executive director.

Nov. 19.—Foundry Equipment Manufacturers association. Fall meeting in New York. H. W. Standart, Northern Engineering Works, Detroit, is president.

Dec. 2-6—American Society of Mechanical Engineers. Annual meeting at Engineering Societies building, New York. Calvin W. Rice, 29 West Thirty-ninth street, New York, is secretary.

Dec. 2-7—National Exposition of Power and Mechanical Engineering. Grand Central Palace, New York. Charles F. Roth, Grand Central Palace, New York, is manager.

Assets to the Bookcase

Review of Books Pertaining to Design

Designing For Production

Production Design, by J. K. Olsen, cloth, 212 pages, 6 x 9 inches, published by the McGraw-Hill Book Co. Inc., New York, and supplied by *Machine Design* for $3 plus 15 cents postage.

Designers encounter regularly the question of fixing tolerance limits on work to go into production. Some of these limits are governed in accordance with personal experience, others from standardized practice. But many cases arise which cannot be included in the foregoing. In his book *Production Design,* Mr. Olsen has contributed a valuable and aptly illustrated treatise covering the general aspects of this important subject. He gives also much pertinent information on such matters as production raw materials; heat treatments; standard gages of raw materials; finishes; stampings and die-made parts; fastening, locking and compensating means.

The gist of the book may perhaps be best gathered from the following paragraph from the author's preface:

"In order to meet successfully the highly competitive markets of today, products must continually be made better, and at a lower manufacturing cost. In all industries this is accomplished largely by employing modern methods, equipment and the best production designing ability. The production designer must always bear in mind that any unnecessary operation, or slightly excessive amount of raw material, when multiplied by the number of parts produced, will increase the manufacturing cost proportionately. He should also remember that the largest possible tolerance or leeway will result in fewer scrapped parts, work less hardships on the production departments and decrease the cost of manufacture."

In the earlier portions of the book Mr. Olsen deals with production, specification, tolerances and fits. The latter include knurling and serration fits, grinding and punch tolerances, and percentage allowances in figuring pileups.

A valuable chapter is included on the allowances for gears and gear centers, and in this chapter is shown a diagrammatic illustration giving six examples of the factors arising in fixing the limits for gear centers. In this illustration, which is typical of many others in the book, it is shown that in some cases as many as 13 factors may arise to influence the tolerances allowable for a pair of bushed spur gears running in mesh.

The book is well worth-while for designers, manufacturers and others for whom it is intended, covering as it does the subject of what must be included in drawing specifications for large scale production in a concise yet comprehensive manner.

* * *

Handbooks of General Information

Machine Shop Practice, seven volumes, 2619 pages, flexible fabrikoid bindings, 6 x 8½ inches, published by American Technical Society, Chicago, and supplied by *Machine Design* at $29.80, with postage extra.

In these volumes of books, not only have the simplest operations of the designer, the machinist, the tool maker, the pattern maker and the foundryman been carefully explained, but the treatment has been carried into the newer and more complicated details of mechanical development. Production methods that have enormously increased the output of our shops and the machines which have made this development possible—speed lathes, planers multiple drillers, grinders, milling machines, stamping machines, die presses and the jigs, tools, and dies which go with them—all are carefully and thoroughly discussed.

It would be impossible in a brief review, to cover all or nearly all the subjects dealt with in these books. Sufficient to say that for the designer who finds it impossible to keep closely in touch with shop operations and practice they contain a fund of well-indexed information on these subjects. Included also are sections dealing with metallurgy, foundry work, shop management, mathematics, physics and so forth.

The books, tastefully bound, contain 2670 illustrations, and number among the authors many leading engineers and college professors.

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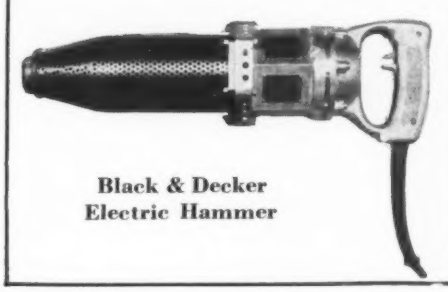

Black & Decker Electric Hammer

The 16 gauge perforated steel barrel shown above is an example of G. P. & F. engineering ability. This black shell is a formed, welded, perforated steel fabrication, made for the Black & Decker Mfg. Co., of Towson, Maryland, as the barrel for their Electric Hammer. The advantage of using a barrel of this kind, they find, is that one barrel is exactly like the other, is light in weight, takes a very high finish and makes the completed tool a very good looking job.

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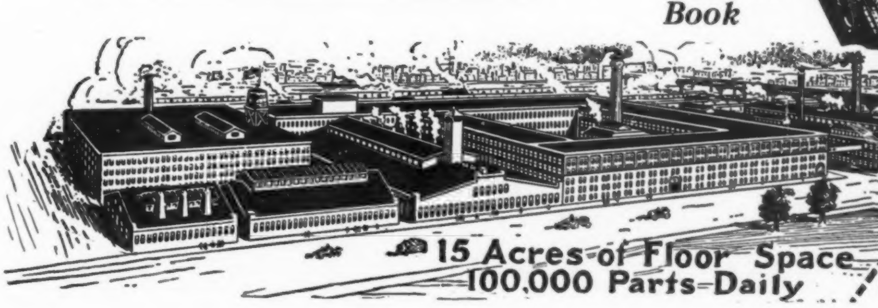

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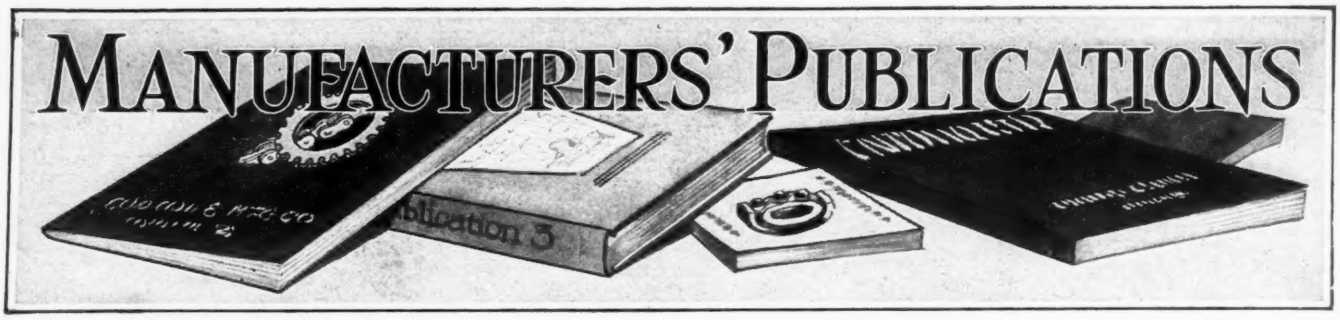

MACHINE DRIVES—The Hertzler & Zook Co., Belleville, Pa., is issuing a four-page circular describing its service in the individual motorization of industrial plants. The motor drives made by the company are designed chiefly for use on machine equipment which was primarily intended for group drive.

ELECTRIC HEAT—General Electric Co., Schenectady, N. Y., describes the application of electric heat to the metal, ceramic, chemical, printing, food, and other industries in a recent folder. The bulletin is illustrated with reproductions from photographs of typical installations.

CIRCUIT BREAKERS—Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa., recently issued an 8-page folder on its indoor, manually or electrically operated, 2, 3, and 4-pole, single throw, 400, 600 and 800 ampere, 15,000 volt oil circuit breakers. Application, distinctive features, mounting and construction are given together with tables containing data on the breakers and their accessories. Dimensional drawings also are included.

GRAY IRON CASTINGS—Gray Iron institute, Terminal Tower building, Cleveland, has released to its members a book listing more than 2000 uses for gray iron castings.

STEEL CASTINGS—Farrell-Cheek Steel Foundry Co., Sandusky, O., has issued a 12-page folder on its special steel for castings for shock, wear, impact and abrasion.

SPEED REDUCERS—Ohio Gear Co., 1333 East 179th street, Cleveland, is distributing a new catalog No. 29-a which illustrates its speed reducers, gear boxes, couplings, pulleys, etc. Detailed drawings and specifications are shown.

BEDPLATES—Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa., has published an 8-page booklet on its bedplates for Westinghouse-Nuttall speed reducers. The bulletin describes the bedplates with and without outboard bearings and contains drawings and tables giving their dimensions.

BALL BEARINGS—A 20-page booklet devoted to precision ball bearings of open and closed types has been issued by the Norma-Hoffmann Bearings Corp., Stamford, Conn. Stress is placed upon the meaning of and commercial value of precision in connection with ball bearings. Details of design are discussed and sizes, dimensions and load ratings are presented for various types of bearings.

CHROME IRON ALLOYS—A 12-page booklet has been published by the Rustless Iron Corp. of America, 122 East Forty-second street, New York, in which four new alloys are described. All are made by a process of direct reduction of chrome ore invented by Roland Wild. The four brands are known as Defirust, Special Defirust, Defistain and Defiheat. Full information on analyses, physical properties, fabrication and uses of each is given in the booklet.

SPLIT FLANGED PIPE—Duriron Co. Inc., Dayton, O., describes its split flanged pipe in sizes 1 to 8 inches, in its bulletin No. 159. Resistance to industrial and commercial corrosion is stressed. The metal is so hard all finishing operations are performed by grinding. Another bulletin describes the chemical and physical properties of duriron. These bulletins are furnished free upon request.

BALL BEARINGS—The second edition of the Gurney ball bearing manual was issued in July by the Gurney Ball Bearing division of the Marlin-Rockwell Corp., Jamestown, N. Y. It is a condensed handbook for the aid of engineers and designers in selecting and applying Gurney ball bearings. Complete technical data is presented and the book is well indexed.

NICKEL CAST IRON—In bulletins Nos. 201-a and 207, the International Nickel Co., Inc., 67 Wall St., New York, presents data on the properties and applications of nickel and nickel-chromium cast iron. Uses in aeronautical, automotive machinery, power, railroad and general industries are outlined.

SPEED REDUCERS—Standard worm and speed gear reducers, 1/30 to 1/3 horsepower, are described with complete specifications in a four-page booklet issued by the Janette Mfg. Co., 556 West Monroe St., Chicago.

LINESTARTERS—Reverse linestarters for squirrel-cage induction motors are described and illustrated in a leaflet recently issued by the Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

BRONZE—A folder on Revere 95 bronze has been issued by the Tauton-New Bedford Copper Co. division of the Republic Brass Co., Tauton, Mass. This is a gilded material for enameled emblems and nameplates.

HYPOID GEARS—An eight-page booklet entitled "Automotive Hypoids" has been issued by the Gleason Works, Rochester, N. Y. The characteristics, advantages, design and manufacture of these gears are outlined briefly.

HIGH TEST CAST IRON—The Dursar Corp., Newark, N. J., has just issued a four-page circular on Perlit, a high test cast iron. Perlit is described as a gray iron, which, while approaching steel in strength, possesses the advantages of cast iron as to ease of manufacture and satisfactory rubbing surfaces. Numerous applications are listed in the circular, photomicrographs are presented and Perlit licensees throughout the world are listed. Perlit castings are being produced and sold by the Davies & Thomas Co., Catasauqua, Pa.

TEXROPE—Allis-Chalmers Mfg. Co., Milwaukee, has issued a profusely illustrated machine tool leaflet, No. 1236-A, presenting its texrope for machine tool drive. Applications of this rubber and fabric power transmission belt to grinders, lathes, polishers and buffers, drill presses, boring mills, bending and punch presses, planers, milling machines as well as miscellaneous equipment, are shown.